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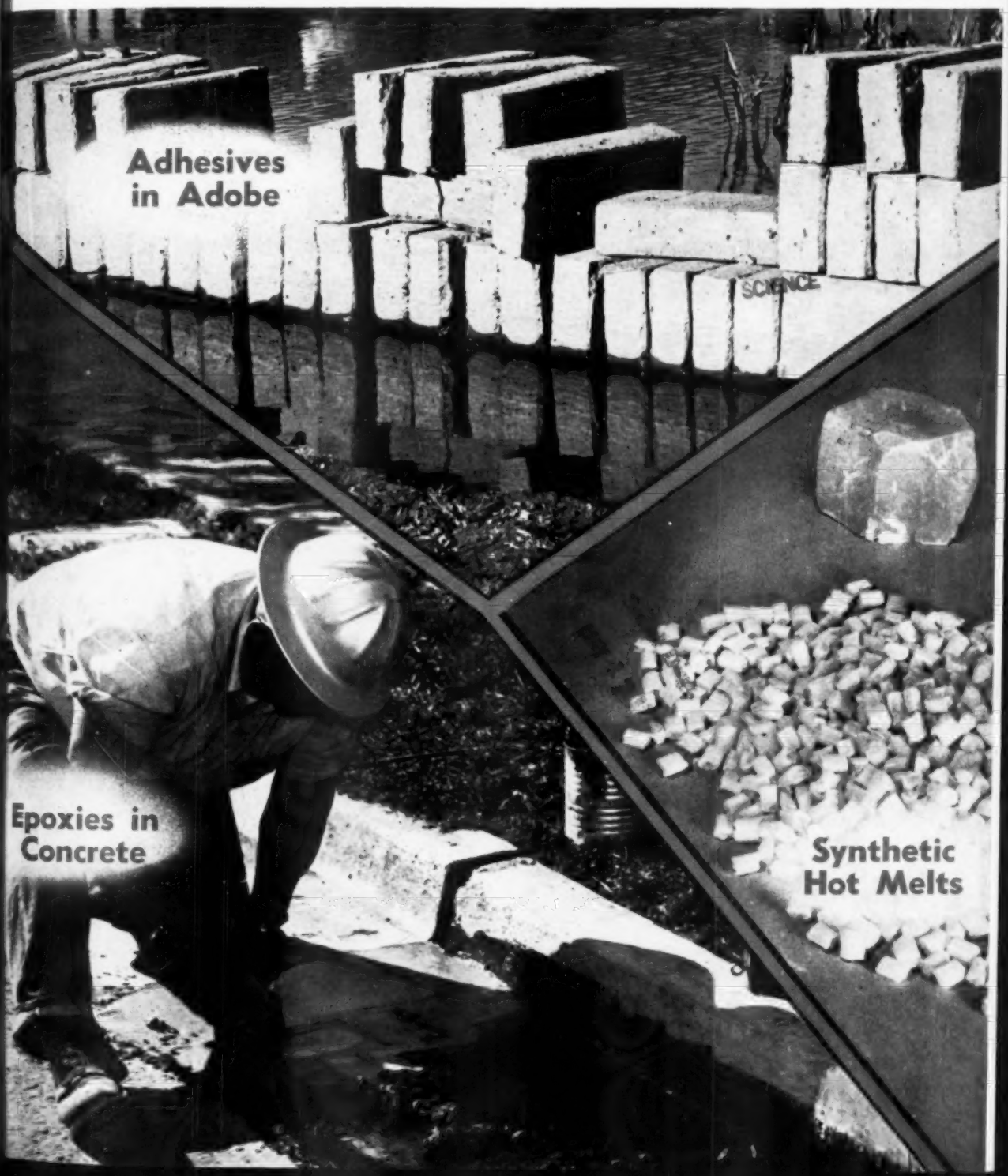
ADHESIVES AGE

MANUFACTURE, APPLICATION, TECHNOLOGY, RESEARCH AND MARKETING

MAY, 1960



News about

B.F.Goodrich Chemical *raw materials*

You can get many advantages through using Geon vinyl solution resins for adhesives. They find application wherever strength, clarity or excellent adhesion is a requirement. Adhesion is good to metal, glass, wood, masonry or paper. At the same time, Geon contributes a resistance to the effects of most acids and alkalis, corrosive atmospheres, oils, greases and food products. There is no taste or odor, and the rate of water vapor transmission is low.

Geon solution resins are compatible with several resins, gums and waxes with unusually advantageous properties for certain applications. Many other materials are compatible only in limited proportions, but are nevertheless very useful in preparing specific formulations.

A specific example is in patching or repairing compounds that are made with Geon—these "cold solders" require no heat, are fast drying, adhere excellently to many materials, and can be smoothly finished over the resulting hard, metal-like surface.

For more information on how Geon solution resins can help you in adhesives, write Dept. GB-1, B.F.Goodrich Chemical Company, 3135 Euclid Avenue, Cleveland 15, Ohio. Cable address: Goodchemco. In Canada: Kitchener, Ontario.

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STABOND
Adhesives
Coatings
Sealants

"TAILOR-MADE" ADHESIVES REVOLUTIONIZE FASTENING

SPECIFIC PURPOSE STABONDS PROVIDE EFFICIENT NEW FABRICATION METHODS

Increasingly, in every industry, development and efficient manufacture of advanced components must rely on a new bonding agent produced especially to meet unusual specifications.

Adhesive science is fast becoming a process of taking a pressing need and tailoring a practical answer where none has previously existed.

Nowhere has the state of this modern art advanced more rapidly than at the Freedlander R & D Laboratories, American Latex Products Corporation.

Today, in hundreds of applications, "specific-purpose" Stabond adhesives, coatings, and sealants are solving fastening problems to permit product advances and fabrication economies.

This continuing creation of outstanding bonding agents has had a double impact vitally important to every design engineer:

1. Provides a large list of tested adhesives with unusual properties immediately available to every industry.

2. Constant production of successful new adhesives means accumulation of knowhow at an exponential rate and makes American Latex an ideal source for technical consultation on any adhesive problem.

You are invited to contact American Latex for a survey of your own adhesive needs and an analysis of how "specific purpose" Stabonds might cut costs, improve quality, speed production, and save labor.

Footrests Bonded Successfully

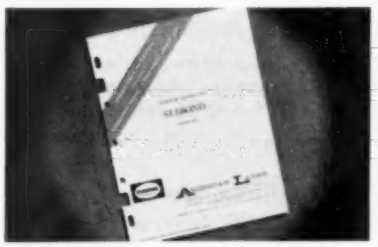
Airliner footrests exposed to roughest wear hold fast when fabricated with new Stabond C-143. Ideal for rubber-to-aluminum seals, this new modified Hycar base adhesive bonds rigid or low plasticized vinyls, natural and synthetic rubbers to themselves or to nonporous metal surfaces.

Metal Bond Withstands 500° Temperatures

Stabond EP-115 two-component epoxy base adhesive recently developed by American Latex has produced metal-to-metal bonds resistant to temperatures in the range of 450° to 500° F.

The new material is also suitable for casting purposes such as tooling, dies, match plates, prototype molds, etc.

This highly filled compound, after cure, can be machined, sanded, filed, drilled and tapped similar to a light metal alloy.



Tech Data Available

Formulations and specifications of standard Stabond adhesives developed by Freedlander Research and Development Laboratories is available in a technical information bulletin.

Organized as to principal use, type, color, coverage, shelf life, temperature limits, consistency, tack period, flammability, toxicity, etc., the bulletin is a handy reference for every adhesive user.

Copies will be sent to interested parties upon request. Contact Freedlander Laboratories or your nearest American Latex branch office.

EP-110 Cuts Fabricating Costs

Efficient and time-saving bonding methods in the fabrication of metals, glass, wood, thermosetting plastics, hard or vulcanized rubber, are made possible by Stabond EP-110, new two component adhesive developed by American Latex. Unique mixing system makes EP-110 easier to use than traditional two-component bonding agents; eliminates measuring, weighing, waste. Stabond EP-110 will cure at room temperatures or can be oven heated for rapid setting.

Freedlander Lab Develops 28 New Adhesives

Current product list of the Adhesives Division of American Latex Products Corp. numbers in excess of 150.

Freedlander Research and Development Laboratory, American Latex R & D facility, successfully developed 28 new adhesive products during 1959.

More than 480 adhesive formulations have been perfected in the Freedlander Adhesive Laboratory, providing a substantial backlog of technical understanding. Adhesive Laboratory personnel at American Latex have a total experience of over 65 years, a rare background in the young adhesive industry.

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ADHESIVES AGE
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In This Issue

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About the Cover Photograph

Three of the articles featured in the current issue are spotlighted by this month's cover. The photo segment at the top of the montage underlines the waterproof qualities of adobe brick made with an adhesive. Epoxy-modified concrete is used, lower left, to make fast road repairs. Some of the synthetic resins that are challenging natural hot melts are shown on the right.

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PP PALMERTON PUBLISHING CO., INC.

MAY, 1960
VOL. 3, NO. 5

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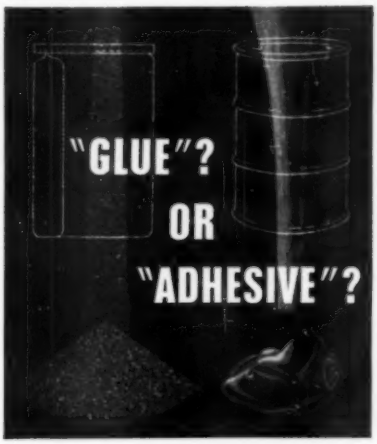
Indexed in Industrial Arts Index and Engineering Index.
© Palmerton Publishing Co., Inc., 1960

10,600 Copies of This Issue Printed

ADHESIVES AGE is published monthly by the Palmerton Publishing Co., Inc. Printing Office, Bristol, Conn. Editorial and Advertising Office at 101 West 31st Street, New York 1, N.Y. Subscription in the United States, $5.00 a year; Canada, $5.50; Foreign, $6.00; Single Copy, 50¢. May, 1960. Volume 3, Number 5.

No matter what you call it...



—when you order a prepared ADHESIVE from your regular supplier, be sure to specify a product based on *performance-proved animal glue*—or

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Published Monthly by
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Editorial and Advertising Offices
101 West 31st St., New York 1, N. Y.
Phone: PEnnsylvania 6-6872

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EDITORIAL

A Guest Editorial

Comment On Stature

For the adhesive manufacturer, the future shines like a new penny and promises a nest of golden eggs. Daily inquiries—the brainstorms and the practical—tell him that ideas about adhesives are rapidly pervading the managerial and technological thinking behind every conceivable type of fabrication. But the "goose that lays the golden eggs" in this story is the word "stature."

Following World War II, the adhesive industry began to stir within the venerable glue pot. It was nurtured and fed on advanced civilian and military technological developments. Spiraling economic pressures provided the impetus for improvements in applications and manufacturing techniques.

New materials, exemplified by the synthetic SBR, butyl, nitrile, neoprene, polysulfide and silione polymers combined with a myriad of epichlorohydrin, phenolic, amino, polyester, acrylic and polyamide resins to implement this rapidly expanding industry. With good cause, the use of adhesives over the past decade has become a functional and practical method of fabrication in a wide segment of industry heretofore limited to bolts, nuts, rivets, and screws.

Use of adhesives proves economical when assembly techniques include proper engineering and application design. Adhesives permit fabrication of smooth surfaces required for aircraft and missiles; they facilitate assemblies involving thin, fragile and sometimes dissimilar components, and provide continuous bonds that can and do serve as anti-corrosion seals.

The stature of adhesives as an integral part of varied fabrication industries has been established and its continued growth seems assured. But to maintain and to increase this stature we must—as an industry and as individuals—police our promotional efforts. Inquiries spotlight a variety of misconceptions—shared by technicians and laymen alike—as to the application limitations of existing adhesives. These misconceptions often reflect the exuberant and sometime errant claims and promises promulgated by our industry—too often adversly. These utterances erode confidence.

It is axiomatic that without the continuing temper of patience and prudence and truth, the stature of our industry will fade and our products, of necessity, will become subordinated—the goose will be dead.

W. E. Kelly
Manager, Adhesives Department
Chemical Division
Goodyear Tire & Rubber Co.

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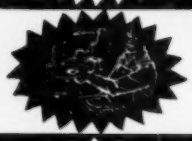

COATING
Trowellable for sealing cracks in walls, concrete pipe, gelcoating of molds and patterns, gloss coating, sheet metal bonding and sealing

LAMINATING
Glass cloth lamination, impregnation of felt and concrete, reinforcement of glass for sheet metal repair, fabrication of ductwork, chemical storage tank lining

FILLING
Aluminum or steel paste for metal repair, sealing of seams, wire rope terminal potting, bonding metal to metal, body work, mounting bolt grouting, filling porous castings

Furane formulates epoxies for these and many other uses. Contact us for specific information concerning your particular application.

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CONSULTANT'S CORNER

By Dr. Irving Skeist

Polysulfide to Gypsum Cement

Question: We need to bond a ¼"-layer of polysulfide rubber to a gypsum cement backing. The adhesive is applied to the gypsum and the gypsum backing applied to a positive face block. The thickness of the rubber is controlled by rigid gypsum spacers between backing and face, and the rubber is introduced in liquid form through inlets in the backing. The rubber is cured at room temperature or slightly above, with the aid of a chemical curative. The result is a rigid backed, flexible faced mold.

We have been using a phenolic resin-nitrile rubber blend. However, it does not have the strength of bond we desire under many conditions, including the presence of water. Can you suggest adhesives for trial with increased strength as the principal goal?

Answer: The phenolic-nitrile rubber adhesive should be quite satisfactory. Possibly you need to apply more heat to cure it properly. Try vulcanizing at 275°F. If heat can't be used, try a neoprene-phenolic blend. *Q-150*

Waterproofing a Fish Pond

Question: I have an outdoor fish pond, 6' x 14', that has a concrete bottom and brick masonry sides. It does not hold water. How can I make this pond leak proof?

Answer: If you have a slow leak, try a waterproofing paint based on chlorinated rubber (Hercules Chemical Company's Parlon, for example). If you have large gaps to fill, there are various epoxy resin combinations that can do a good job. *Q-148*

Readers who would like to contribute their own experience with problems similar to those discussed in Dr. Skeist's column are invited to write to ADHESIVES AGE, *101 West 31st Street, New York 1, New York. Please refer to the code number given at the end of each question and answer group.*

CONSULTANT'S CORNER

Phenolic to Nylon

Question: We have been having difficulty fastening a small nylon window into a phenolic block. The window covers the pilot light of a coffee maker. Since the utensil is submersible, we cannot have any leaks at the window. In addition, the window must withstand a test pressure of 15 psi and an operating maximum temperature of 250°F.

We have been using a two-component epoxy cement and curing it at 300°F. for half an hour, but "leakers" have been a considerable problem. Can you recommend any other adhesive system which might be superior for this application? This has proved quite a production problem.

Answer: The curing temperature sounds very high. If this is the recommended temperature for the adhesive, then you may be using an epoxy that is formulated for high heat resistance but lacks the resilience to stand up to repeated cycling between room temperature and 250°F. It should be possible to modify the hardener system to give a tougher bond that will still have adequate heat resistance.

You may get better results, however, from a phenolic-nitrile cement comprising a phenol-formaldehyde resin and a butadiene-acrylonitrile rubber dissolved in a ketone solvent. Just enough nitrile is used to provide adequate toughness and adhesion to nylon. The cement is applied to both surfaces and the solvent is evaporated before bringing the adherends together; then the joint is cured at an elevated temperature.

Q-146

Decal Adhesives

Question: We are manufacturers of decalcomanias and are very interested in finding a good adhesive for use on our large truck decals. The adhesive would have to conform to the following:

(1) It would have to permit silk screen to be applied to the top of synthetic enamel run on a duplex type decal paper.

(2) It should be water activated.

(3) It must have permanent bonding qualities, and the design must adhere to painted and bare aluminum surfaces.

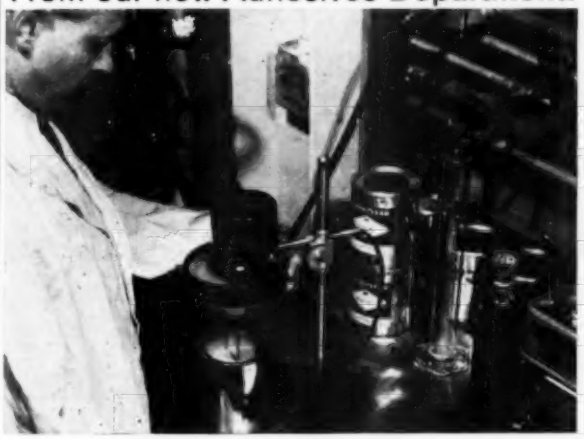
Can you give us any information? We would be grateful for any help.

Answer: It may be advisable to ask your adhesives supplier for a pressure-sensitive rather than a water-activated adhesive, in order to insure good weathering properties. A common type of water-activated adhesive for decals is compounded from a rubber latex plus a water-soluble polymer, such as polyvinyl alcohol, to permit remoistening. Such a composition would be too sensitive to rain. On the other hand, pressure-sensitive adhesives are readily formulated for water resistance.

The pressure-sensitive coating will have to be masked with a release paper which is peeled off before applying the decal to the metal surface.

Q-134

From our new Adhesives Department:



4 new and unusual

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ADHESIVES

New and yet not new. That's our Adhesives Department. For although newly formed to give you better service in the increasingly important field of chemical fasteners, it's founded upon well over a half-century of experience in developing and manufacturing tailor-made adhesives for a wide range of uses.

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PLIOGRIP 12-7. Developed as a binder of ferric oxide to computer tape. Exhibits high bond strength and excellent flexibility, dries rapidly.

PLIOGRIP 22-4. Designed as a plastisol-to-metal primer in pipe joints. Activates at 350° F. Provides outstanding adhesion.

PLIOGRIP 13-5. Developed to bond chloroprene rubber to nylon sheet or fabric in industrial belt stocks. Reported peel strengths range up to 70 psi.

PLIOGRIP 12-1. Designed as sealant for aluminum and other metallic joints. Displays high strength, lasting flexibility, excellent weather-resistance.

Perhaps one of these new adhesives—or one still under development—can solve your adhesion problem. Why not see your local Goodyear Adhesives Distributor for more information and samples. Or write Goodyear, Chemical Division, Dept. Q-9466, Akron 16, Ohio.

GOODYEAR

CHEMICAL DIVISION

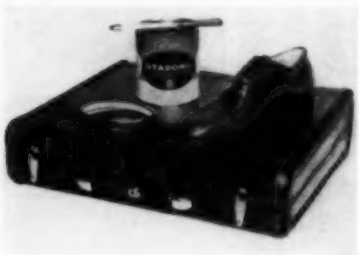
Pliogrip—T. M. The Goodyear Tire & Rubber Company, Akron, Ohio

new adhesives

AND ADHESIVE PRODUCTS

Leather Adhesive

Stabond T-245 is a versatile new leather adhesive said to be fast drying and have excellent strength and application qualities. The material, designed for use in a wide variety of leather industries, provides a bond of sufficient strength to eliminate stitching in certain shoe assembly work, the manufacturer states. Easily applied in brush consistency, Stabond T-245 is compatible with a wide range of tanning finishes and surface



treatments. It can be used with all standard leather materials in the shoe and leatherworking fields. The manufacturer reports that the adhesive creates a waterproof seal while it bonds a joint stronger than the leather itself. In addition, it provides excellent adhesion under loads at both elevated and below zero temperatures. Stabond T-245 has a tack period from 5 to 20 minutes and has the characteristic of remaining where it is placed. If accidently applied outside of the bond area, it can be removed without adversely affecting the leather by marking or spotting. *American Latex Products Corp.*

P-298

Vinyl Adhesive

Wood-Lok 40-0224 is a one package, vinyl assembly adhesive which is said to be the first to provide water resistance without requiring the addition of a catalyst. It features the usual high bond strength, heat resistance and fast setting characteristics of vinyl-based adhesives. The product is suitable for all types of assembly gluing. It is shipped ready for use and requires no heating or mixing. *National Starch and Chemical Corp.* **P-299**

Caulking Compound

Epothane Farbo-Flex, a caulking compound with a life expectancy in excess of 30 years can be used for building, maintenance, steel and highway construction, marine installations, refrigeration, air conditioning, oil fields, refineries, aircraft, railway and automobile manufacturing, the manufacturer reports. The compound remains permanently flexible on the exterior or interior and will withstand extreme continuous expansion and contraction when exposed at temperatures from −65° to +300°F. Adhesion is fusion-like and is not impaired by impact, vibration, contraction, or expansion, the manufacturer claims. In addition, corrosive atmosphere or chemical fumes have little effect on the cured material. According to the manufacturer, Epothane Farbo-Flex is excellent for maintaining new and old buildings; caulking ships, boats, and barges; sealing curtain walls; on porcelain and on marble construction. It is also useful to insulate and seal electrical components against moisture, solvents and contamination, and for sealing expansion joints in the floors, walls, and swimming pools. *Farboil Co.* **P-300**

Rubber Sign Mounts

Metal signs can be bonded to wall surfaces with special sponge rubber mounts containing a driback adhesive on one side and a pressure-sensitive adhesive on the other. The driback side can be reactivated with solvents such as naphtha or toluol. The pressure-sensitive side has a protective backing of polyethylene. The mounts can be supplied in thicknesses from ⅛ to 1 inch and can be cut to any size. They are also supplied with driback adhesive on back side for use where an especially strong bond is needed. *K and M Rubber Co.* **P-301**

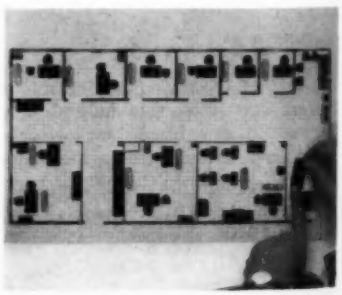
Rubber-To-Rubber Adhesive

Adhesive EX-B150-1 is an experimental material used for heat bonding dissimilar elastomers. It is said to form strong and durable bonds between many combinations of rubbers such as uncured butyl to uncured neoprene, natural rubber, butadiene-styrene rubber, or nitrile stocks. The bonds are flexible and retain their strength and dynamic properties after prolonged exposure to heat and flexure. According to the manufacturer, EX-B150-1 produces good bonds even if one of the stocks is partly cured. The adhesive may be applied by any convenient method to either or both surfaces to be bonded, however, good building tack will be obtained if it is applied to both surfaces. It dries quickly at room or elevated temperature, and bonds are formed during the curing of the elastomers, preferably at temperatures over 250°F. When used with a primer, EX-B150-1 gives good bonds between rubbers and many other substrates such as plastics or metals. It will not adhere directly to metal, and when used in direct contact with fabric, an additive is required. *Hughson Chemical Co.*

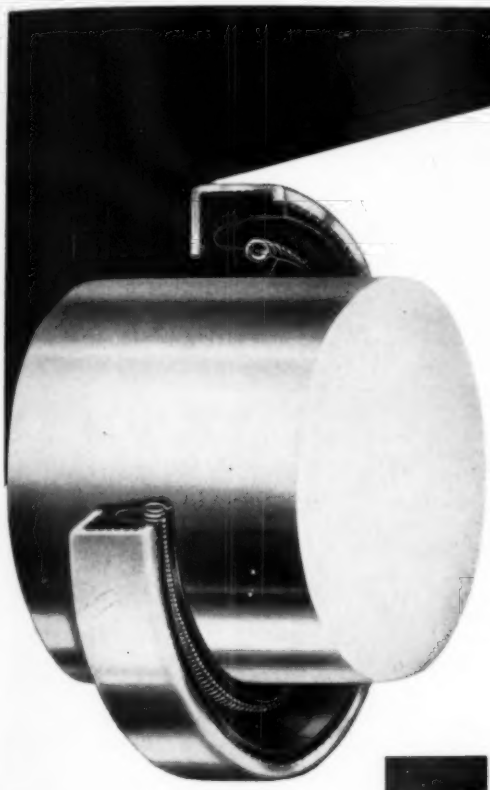
P-302

Self-Adhering Layout Kit

Using self-adhering vinyl symbols which are placed on a translucent plastic grid board, the Planoramics Layout Kit is said to be ideal for planning future office expansion. Scaled ⅛ inch equals one foot, the kit allows the space planner complete freedom in plotting areas of any size and shape. The kit consists of a 20 by 50 inch plastic planning board



with grid, a marking pencil, tape, and representative symbols for every type of office furniture and equipment—48 different size templates making over 1,200 pieces. With this flexible layout kit, no drawing, draftings or erasures are necessary. The self-adhering vinyl symbols are placed on the translucent plastic grid board by hand. They adhere firmly until removed and can be re-used indefinitely. Since the plastic itself is the adhering agent, there is no stickiness. The kit is available with grids scaled to ⅛ or ¼ inch to the foot, either in black or non-photographic blue, making photostatic reproduction possible. *Planoramics.* **P-303**



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Rubber Asphalt Joint Sealer

Bonding well to concrete, steel, masonry and other surfaces and remaining flexible over a long period of time, Join Seal, a new rubber asphalt joint sealer and crack filler, is said to offer a fast, economical way to seal out mositure, drafts, insects and dust. Because it blends rubber and asphalt, it has flexible quality

which makes it possible to stretch as joints expand, and to withstand moisture. Tests revealed that Join Seal retained its flexibility, size and clinging power over a temperature range from 20° below zero to 100° above zero. The sealer comes in a standard tube which fits ordinary caulking guns and has a tip which can be cut to desired width of application. The color is black, but by using aluminum paint first, it can be painted over in any desired color. The manufacturer states that Join Sealer can be used for such applications as sealing foundation cracks, sealing around pipes which run through walls, filling cracks in driveways, sealing metal buildings, repairing roofs, gutters and roof parts. *United States Chemical Co., Inc.*

P-304

Water-Soluble Vegetable Gum

Derived from okra, this highly effective, water-soluble vegetable gum was developed to provide a domestic deflocculating agent for long fibers in specialty paper manufacturing. In the mill, okra is prepared directly in a dilute water dispersion, with only gentle agitation required. This dispersion is added to the paper process anywhere from the beater to the head box. In some cases, the amount of okra gum required may be extremely low. According to the manufacturer, the addition of okra gum greatly enhances sheet formation and increases tensile strength by uniform fiber distribution. *Morningstar-Paisley, Inc.*

P-305

Epoxy Resin Pipe Coating

A new epoxy resin pipe coating that can be applied easily and quickly, Scotchkote brand pipe protection resin No. 101 cures in less than 20 seconds with close coating tolerances. In addition, solvent hazards and post-baking, normally associated with epoxies, are eliminated. Field experience has shown that the resin coated pipe can be handled in much the same manner as bare pipe, the manufacturer reports. Welding of pipe section can be accomplished through the resin coating, once an arc has been struck on a bared spot. The resin, upon application is completely thermoset, and will not flow under pressure nor flow upon heating. It has an adhesion strength of 3,000 psi, and high impact strength which resists damage from soil or pipe movement, and the abrasion and shock of back-filling. Scotchkote No. 101 is said to resist attack by most chemicals, including hydrocarbons such as fuel oil, gasoline, kerosene, and sweet or sour crude. *Minnesota Mining & Manufacturing Co.*

P-306

Cured Rubber Sealant

E-Bond No. 1007 sealant is a positive, permanently pliable sealant compound based on Thiokol free flowing liquid polysulfide polymers. It cures to a tough rubber-like seal that will not shrink, crack, oxidize, or become brittle. Chemically inert, it resists acids, alkalies and solvents. According to the manufacturer, E-Bond No. 1007, has a superior adhesion that bonds glass, metals, masonry or wood to virtually any surface and remains unaffected by the most severe temperature changes. In addition, the manufacturer claims that it is unexcelled for water-proofing the joints of curtainwalls, windows, wall facings, expansion joints or folded plate roofs. *International Epoxy Corp.*

P-307

Adhesive-Coated Label Paper

Davac AP is a new label paper grade in adhesive-coated sheets. A high blocking point is built into the adhesive coating to prevent labels from sticking together during storage under varying climatic conditions. According to the manufacturer, the adhesive does not set immediately, and this factor enables inspectors to straighten improperly positioned labels, which eliminates relabeling of products. *Nashua Corp.*

P-308

Polyester-Base Adhesive

Known as Edilon-P5001, this two part polyester-base adhesive is reported to give strong bonds to such materials as concrete, stone and steel. The two components are mixed on a flat plate in the ratio of 1:1 and to the consistency of priming putty. The hardening period is 20 minutes at 20°C. Two hours after mixing, the joint can be loaded. If longer hardening periods are desirable, basic components giving hardening times up to one hour can be obtained from the manufacturer. To minimize shrinkage due to hardening of the cement, joint thickness should not exceed 5 mm. *Edilon N.V.*

P-309

Curing Adhesive

Polybond G-1448 is a new curing adhesive that polymerizes to an elastomeric bond. It is resistant to solvents and boiling water, and is particularly suited for adhering Mylar and polyethylene. Peel bond strengths higher than one pound per inch are obtainable with the new adhesive. The manufacturer reports that the characteristics of Polybond G-1448 suggest its use as an extrusion prime coat as well as for film laminations used in packaging or weather resistant industrial structures. *Polymer Industries, Inc.*

P-310

Electrical Junction Adhesive

Electrical junction boxes can be bonded to masonry walls, ceilings and floor, metal beams and wood surfaces with Permacel PA-1041 Epoxy Resin Junction Box Mount. The two-part material is packaged in a separator type cup which is the mixing container. The product eliminates

the need for toggle or expansion bolts, rawl plugs, and drilling the surface to which the box will be mounted. It is weatherproof, resistant to acids and alkalies, solvent-free, non-toxic and non-dermatitic, states the manufacturer. *Permacel*

P-311

Durez does not make adhesives, but supplies millions of pounds of resins to people who do.

Why the pinch of permanence may help you make a better adhesive

The giant grip in many of today's aircraft super-adhesives began with a pinch of Durez® phenolic resin in the laboratory.

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capitol cues

YOUR FEDERAL INCOME TAXES WILL PROBABLY BE CUT next year, if current political and economic trends only persist. The U. S. Budget is getting into the best shape of any time since the end of World War II. Continuing good times are boosting profits and incomes--and the Treasury's revenue receipts. At the same time, according to recent surveys, members of Congress want to grant relief--once at least part of the huge federal debt has been paid off. What's more, if a recession should develop, cuts would help boost business.

Here's the way the black ink will be growing in coming years:
- In fiscal 1960, the year we are now in, the Budget should be just about balanced, with spending and outgo at $78.5 billion.
- In fiscal 1961, a surplus of around $3 billion is anticipated. U.S. spending will be up a little, revenue quite a bit more.
- The next year, fiscal 1962, the surplus could jump to around $7 to $8 billion, if business continues good. Receipts would be way up while Federal spending would again rise very little.

The 1962 federal budget will go to Congress early next January. And if a $7-$8 billion surplus is indicated, Congress will be ready to approve tax changes, in advance of actual surpluses.

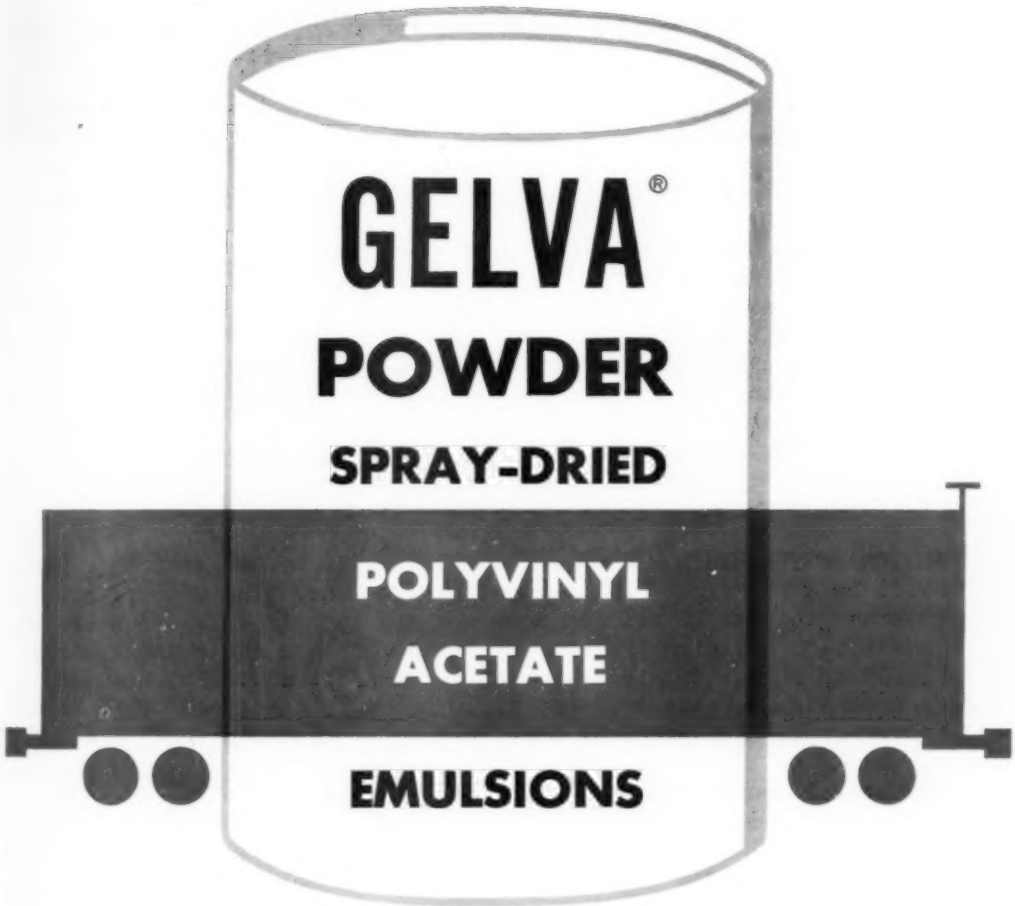
Here's the way Congressmen think the cuts should be made:
- Individuals should be taken care of first. That's normal with Congressmen; they favor the voters and they have the idea that such cuts can stave off a recession. Cuts might be 10% or so.
- Corporations should get some relief, too, if the surplus turns out to be large enough. A cut from 52% to 50% might be voted.
- Manufacturers, also, might be given some relief on the excises they now pay, especially those approved during the Korean War.

Cuts could reach $4-5 billion, with some left for debt payment.

THERE'S STILL A CHANCE FOR THE KEOGH BILL--to give the self-employed deductions for contributions to private pension plans. It passed the House last year. But the Senate has been hesitating because of Treasury dislike. Now the Treasury is ready to go along--if the program is modified some and cut down. This may be all that is needed finally to push the bill across.

A SHIFT TOWARD EASIER CREDIT MAY NOW BE UNDER WAY, judging from recent developments. The tightenings of recent years may at least be reaching an end. This does not mean that you will see a sudden easing in rates and the supply or that credit conditions will return to the ease of the early 1950's. Though the worst of the tightness may be behind us, coming changes will be slight.

There are four factors behind the shift that's now in process:
- The Budget surplus that is coming will act as a deflationary influence; the Treasury will take in more than it will spend.
- Recent business trends don't show the large expansion that was anticipated at the beginning of the year. Industrial output is leveling out while auto sales are not as high as hoped for.
- Commercial loans are not rising at the rate anticipated though it should be noted that they have begun to show some strength.



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GELVA Powders 700 and 702 are Shawinigan Resins' PVAc emulsions **with the water removed.** Now adhesives manufacturers can formulate for the exact amount of solids required, or use PVAc in an entirely dry form . . . and always be sure of the same high quality that distinguishes Shawinigan Resins' GELVA emulsions.

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GELVA Powder 702 has been developed for use in adhesives where dextrine compatibility and borax tolerance are required. It can be used in remoistenable adhesives for the preparation of high solids, low viscosity gums which will provide faster drying than can be obtained with the emulsion form.

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capitol cues (cont'd)

PRICE INCREASES THIS YEAR WILL BE MODERATE, in the view of government experts. Budget surpluses, competition, and prospects of business leveling are helping. Gains probably will be greater at the consumer level than at wholesale. Though the rises will be small over-all, they'll be widespread.

-At retail, gains may average a little more than 1%. Food won't go up at the 2% to 3% rate of recent years, while clothing will be costing about 1% more. Dealer discounts on new cars will hold prices down. But higher local taxes will boost prices on many items. Medical costs will rise.
-At wholesale, the price hikes will average a little under 1%, with farm products easing and metal products going up. A fall in home-building will keep building materials from rising over-all. Machinery prices, though, will increase.

The costs of services will continue to show 2% to 3% gains.

EXPANSION OF THE MINIMUM WAGE LAW WILL BE VOTED by Congress this year. But, there will be a big fight over how it will be done. The Democrats want to extend coverage to some 10 million more workers in retailing, in services, in local transit, and building trades. They also want to raise the minimum from $1 to $1.25 an hour. President Eisenhower and his advisers, however, favor a more moderate increase to, say, $1.10 an hour. And they would rather extend the coverage of the wage-hour laws to only a small number of workers.

In the end, Eisenhower's position probably will be the one that prevails. If any bill passes, it will provide for a compromise covering less than 5 million workers. And some exemptions may be made for firms grossing under $750,000.

NO CHANGES IN GOVERNMENT PATENTS POLICIES are likely to be approved by Congress this year. This will be disappointing news to many companies now working on U.S. contracts. They now have a few rights in inventions developed in fulfilling these jobs. But in many cases the title goes to the government, which will offer these patents, royalty-free, to all of American industry. What contractors want is private control, with only the U.S. having free use.

Senate antitrust leaders are reluctant to give industry the rights to patents without prior review by the Department of Justice and the National Science Foundation. Time will run out this session before a compromise can be reached. Patents on space, medical, and atomic energy contracts are involved.

THE JOB OUTLOOK FOR COLLEGE GRADUATES IS GOOD this year, probably the best ever. Both university officials and industry recruiters agree on this, on the basis of preliminary soundings that were conducted during the Spring. For one thing, demand is increasing. The federal government is aggressively seeking young technical and scientific workers--the ones industry wants most. As a result, the number recruited out of universities will rise 20% over '59.

Starting pay for engineers and scientists will be up by 6% this year, to around $490 a month. Graduates in business administration will be getting about 3% more. Though the recruiting by the federal establishment is currently being stepped up, starting salaries are 15% under industry's.

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REICHHOLD CHEMICALS, INC., RCI BUILDING, WHITE PLAINS, N.Y.

• **Success of American Adhesives in Europe.** A number of American companies in the adhesives industry have been active in promoting their products in foreign countries. A feature article, "Compression Molding of Plastics and Rubbers in Plastic Molds," published in the French trade magazine, *Revue Générale du Caoutchouc,* deals with the application of an American adhesive in the following manner: . . . After an injection and compression molding department had been created inside our Plastics and Rubber Laboratory, the production of molds raised immediate difficulties. The workload of the mold shop was too high and short delivery times could not be kept. A new molder could not solve the problem, since such a worker must stick to a schedule and cannot be disturbed all the time. Therefore, the technique to mold from a pattern was selected and Devcon C was chosen as a material. This United States-made product (the actual contents of which are not given) is no doubt an epoxy resin mixed with a metal filler.

After making one or more patterns according to the required number of casts and taking into account the shrinkage of the molded material—Devcon shrinkage is negligible for small parts—the next step will be to cast the mold. The part or parts are set on a plate according to the chosen joint lay-out and the whole makes up the bottom of what we call the ferrule.

Devcon C, as all resins in this type, shows great affinity to materials with which it is contacted and the pattern must be coated with a stripping agent. Each can of resin is supplied with a small can of an excellent anti-adhesive grease. This is a highly important step, which requires utmost care.

When the coating is over, the plate is fixed to the ferrule and makes a sealed box. This is put in an oven and preheated at 130°C., or 10°C. more than the casting temperature of the resin. The resin, with the filler added, is an aluminum colored, highly viscous paste, and held in a container at room temperature. The stiffener is a rather fine, white powder, which should contain agglomerates, and an evidence of moisture, so as not to jeopardize the results. The resin is heated progressively up to 120°C., and the stiffener is added slowly, and stirred continuously to avoid clotting. The final mixture should be perfectly smooth.

The ferrule, pre-heated at a higher temperature than the resin, to prevent the Devcon to be cooled when contacting the walls, is taken out of the oven and the cast is made. The maximum pot life of the resin-stiffener mix is 20 to 30 minutes, but, as the viscosity is increased in a relatively progressive way, no time should be lost. To help degassing, air bubbles being the main cause of mold failures, the resin should be cast at an angle. Good stirring also gives good results without any risk of air inclusion.

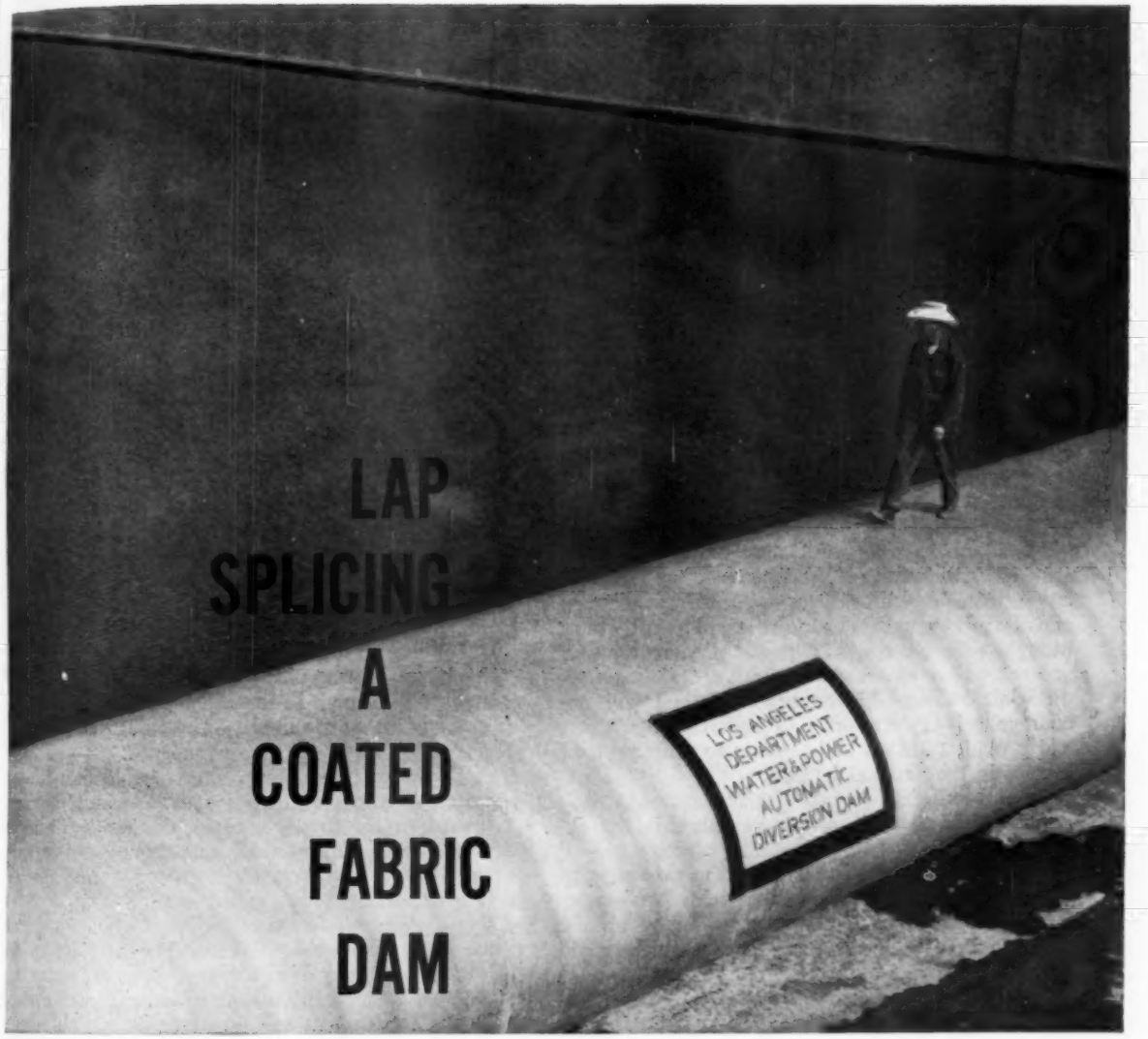
The author describes the subsequent stages of making this particular mold, and concludes by stating: "Finishing includes machining the injection runners and the sprue, and fixing the centering lugs, which could eventually be caught in the mold during casting, provided they are strictly at right angles to the plane of the joint, and mounting the mold centering ring on the press.

"Machining is easy and is similar to the machining of aluminum. Molding is then carried out with an injection or compression press. The dimensions of the mold made, limited by the size of the presses, did not exceed 150mm/150mm (6 inches). A Devcon mold is 4 to 5 times lighter than a steel mold, and this factor is important especially when the mold is being handled manually."

The American firm, Devcon Corp., Danvers, Mass., in addition to promoting its products in France, appears to have a foothold in Germany. The German trade magazine, *Adhaesion,* devotes a great deal of space to the description of one of the firm's new products, Devcon Two-Ton Super Glue, which was reviewed in the following manner:

Devcon Corp. has recently developed a new epoxy adhesive similar to the so-called "plastic steel" which consists of a mixture of a liquid resin and metal powder which, after curing, resembles metal. It is claimed that the new adhesive has tremendous bonding power, and one drop suffices in most cases to bond all materials when repairing most household items.

The new adhesive is supplied in tubes and is based upon the adhesives which the company has developed for the aircraft and similar industries. The new adhesive can be used for bonding steel, aluminum, porcelain, glass and other materials to repair such items as ice boxes, lamps, bathtubs and all other major and minor appliances in the modern household. The company emphasizes in its promotion literature that this adhesive can replace screws, bolts and similar fasteners. Because the adhesive is white in color, repairs of porcelain-enameled metals can be made, and, after drying within two hours, they will look exactly as the original enamel.



This unique dam made of neoprene-coated nylon fabric spans the width of the Los Angeles River. The Los Angeles Department of Water and Power uses it to divert much needed water into underground basins. The dam is inflated with water; during flood stages, it can be collapsed to lie flat on the river bottom.

Seams on this 150-foot dam occur every 30 feet. A lap splice was made practical through the use of a newly developed neoprene-based adhesive. This adhesive air-dries at room temperature or can be cured. It's easy to apply. In service it holds tight during inflation or deflation, withstands abuse from water-borne debris and is unaffected by constant exposure to water, weather, sunlight and ozone.

Neoprene-based adhesives are available from adhesive manufacturers in both solvent and latex types. They may be formulated for application by brush, spray or roller and meet a wide variety of service requirements. If you need a better adhesive, ask your supplier about adhesives based on Du Pont neoprene or write E. I. du Pont de Nemours and Co. (Inc.), Elastomer Chemicals Department AA-5, Wilmington 98, Delaware.

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On the Continent (cont'd)

• **National Export Expansion Program.** We frequently have pointed out how important the expansion of our export trade is in order to reduce the deficit in our balance of trade. It is gratifying to know that a number of industries in our line are doing a good job by expanding their overseas contacts and supplying several foreign countries with their products.

In view of the importance of the expansion of our exports, the government has instituted a national export program. The rising tide of prosperity abroad has created new opportunities for the sale of American goods. Progress toward the achievement of an expansion of United States exports in growing world markets is dependent on vigorous, imaginative and enthusiastic undertakings at home and abroad. United States business and industry must bear the principal responsibility for a more vigorous and effective commercial effort but, at the same time, the United States Government can and will encourage private enterprise to undertake the effort and provide facilities and services to promote their success in the national interest.

Studies and field reports clearly show that additional United States Government efforts in the export promotion field can be fully effective only if private enterprise can be stimulated to take a much more active interest in the export field. The following recommendations provide a real hope for the future and represent a course of action which should be initiated *now*.

(1) The executive branch of the government will give priority to the promotion of United States exports as being in the national interest. A sense of urgency, national purpose and dedication of intellectual and physical resources to this end is required. The Departments of Commerce and State will accord this program high priority.

(2) An integrated export promotion drive, at home and abroad, should be initiated immediately and developed as rapidly as possible.

a. The Department of Commerce will undertake to stimulate the interest of United States business in export trade through a variety of vigorous promotion programs. Firms, new to the trade and those already exporting, will be made aware of the value of export markets, the importance of expanded exports to the national growth of the United States and of the facilities made available by the government to assist them. United States businessmen should be stimulated and oriented towards foreign market opportunities. Particular attention would be paid to the needs of medium-sized and smaller business firms.

b. The Department of Commerce will improve and expand its export trade services. Included in this proposed improvement and expansion are: the preparation and dissemination of foreign market surveys on a specific product and country basis; improved techniques for dissemination of trade opportunity leads; analysis of major competitive weaknesses of United States exports; information of foreign economic and trade conditions, and practical advice designed to help American firms get into the export business, and increased efforts to improve personal contact with American businessmen through domestic field offices.

c. The Department of State would establish a vigorous re-emphasis upon trade promotional activity on the part of the Foreign Service. Greater efforts would be devoted to assisting United States business to find and compete for export markets. To this end, commercial officers have been directed to travel more widely in their area of assignment, give more personal attention to visiting businessmen, attend bid openings to the extent practicable, and encourage use of United States standards and specifications.

d. The Export-Import Bank would provide export guarantees of non-commercial risks for short term transactions. In addition, the bank will undertake the expansion and improvement of existing credit and comprehensive guaranty facilities for medium-term export transactions.

(3) Promotion of travel to the United States will be given additional emphasis. The new set-up will make it possible, even for small companies, to start a forceful export drive. By contacting the field offices of the Department of Commerce, it will be easy to find out in what part of the world a market exists for a particular product.

• Thermosetting Resin Composition and the Use Thereof is the subject of a British patent recently granted to Ciba, Ltd. Shell molds are made from a mixture of sand and a resinous binder (containing phenol-formaldehyde resin) poured on to a heated pattern made of metal. The metal pattern is usually machined from a casting and extremely costly. It has been found that a pattern made from an epoxy resin can give excellent results. The pattern of epoxy resin may be produced by casting in a mold, such as plaster of paris, with a minimum cost.

• How to Reduce the Danger of "Runs" in Hosiery is the subject of a patent granted recently to a German inventor. He proposes an immersion treatment of stockings to reduce the danger of "runs". The immersion bath contains highly polymerized polyisobutylene, less highly polymerized polyisobutylene, and polychloroprene or chlorosulphonated polythene (one to two parts each, together in 100 parts of water). The film does not affect the elasticity and flexibility of the stocking.

ADHESIVES GUIDE

by JOYCE HURD

• A Practical Handbook

designed to serve as a guide to the types of adhesives available for bonding various materials in various applications. This new British publication covers adhesives used in woodworking, bookbinding, footwear, etc., and offers valuable data on the advantages of adhesive bonding and the classification of adhesives.

Topics Covered

Choice of Adhesives for Various Materials.

Encyclopedia of Basic Adhesive Types.

Classification of Manufacturers (British) by Basic Types of Adhesives Made

Catalog of Adhesive Manufacturers and Their Products

Trade Name Index (British)

Miscellaneous Adhesive Recipes

British Organizations Concerned With Adhesives

Bibliography

With contents including data on something like 400 individual adhesives made by about 100 different manufacturers, this publication will prove to be a valuable edition to your technical library. More than 50 main types of adhesives and their properties are covered!

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How An ADHESIVE Modernized Adobe

Addition of emulsified asphalt to adobe mixture makes finished brick waterproof

Adobe, one of the oldest construction materials, is now getting some of the attention it deserves among builders—thanks to an emulsified asphalt adhesive known as Bitudobe.

Traditionally, adobe is made by mixing sand loam soil with water and such reinforcing media as string or straw and then allowing it to dry in rectangular molds or brick casting forms. Clay serves as a binder in the resultant brick, and structures made therewith are not nearly as short-lived as many persons imagine. For example, several missions made from adobe more than 300 years ago are still standing in Southern California.

However, the adobe of yesteryear was not waterproof and, unless it was carefully maintained or protected, it could resume its natural role as soil in the course of a few rainstorms.

Adobe made with an emulsified asphalt adhesive can, on the other hand, be immersed in water for weeks at a time without a loss of mechanical strength or structural integrity. In addition, it has a number of special virtues, as we will see.

Among contractors who currently specialize in the field of adobe masonry is P. E. Aguilar of Santa Barbara, Calif. Mr. Aguilar points out that an immediate advantage of the technique is that he can get most of the soil he needs for brick right from areas where actual construction work will be done.

"In some instances," he explains, "it is necessary to add a little sand to the soil in order to improve its casting characteristics by lessening its natural clay content."

First, common tap water is used to moisten the soil, so that the lumps therein can be readily broken up after a soaking interval that usually lasts several hours. Then the moist soil is blended with additional water until it has a uniform texture similar to that of castable concrete. At this stage, the emulsified asphalt is added and mixing is continued until the adhesive medium is thoroughly dispersed. The mixing can be manually done in a mortar box, but contractors like Aguilar generally use paddle or pug-mill types of machinery.

Open-End Molds

Molds in which the blended adobe mixtures are cast are usually rectangular wood frames with two open ends. Each mold is generally large enough to contain two or more ordinary ceramic bricks. Inner surfaces of the forms are sanded and painted to assure the production of smooth brick surfaces.

Troweling and manual ramming is done as necessary to assure the proper filling of molds with adobe.

The brick castings will usually become dry enough to be handled a day or two later. At that point, each mold is tilted up on one edge for at least 24 hours to complete the drying cycle.

The adobe bricks are subsequently built up from a cast concrete foundation around a more or less conventional wood or metal frame. A standard Portland cement mortar is used to bond the cast brick together. In some cases, steel reinforcements are embedded in grout between the brick components—just as in conventional masonry.

Though fairly expensive because of the high labor and handling costs involved, modern adobe is rapidly gaining popularity in the construction of quality homes and small commercial buildings as the result of its many inherent advantages. These include:

Attractive appearance—it is eminently suitable for Mediterranean, Mexican, Mission, and Early Californian architectural applications.

Excellent thermal insulation—which means better ability to retain heat in the winter and to maintain lower building temperatures in the summer.

Moisture proofness—it lacks even the tendency of conventional masonry materials to "sweat" during cold or wet weather.

Sound proofness—it frequently eliminates the need for special sound-deadening materials.

Fire resistance—modern adobe is like its predecessor to the extent that it won't support combustion.

Insect repellence—which means that, unlike its predecessor, modern adobe discourages such destructive insects as termites (an important point, since the occupants of adobe buildings nowadays appreciate such refinements as wood floors).

Earthquake resistance — adobe buildings can have greater mass than structures commonly made with other materials.

Maintainability—which means that waterproof adobe can retain its natural appearance and properties indefinitely.

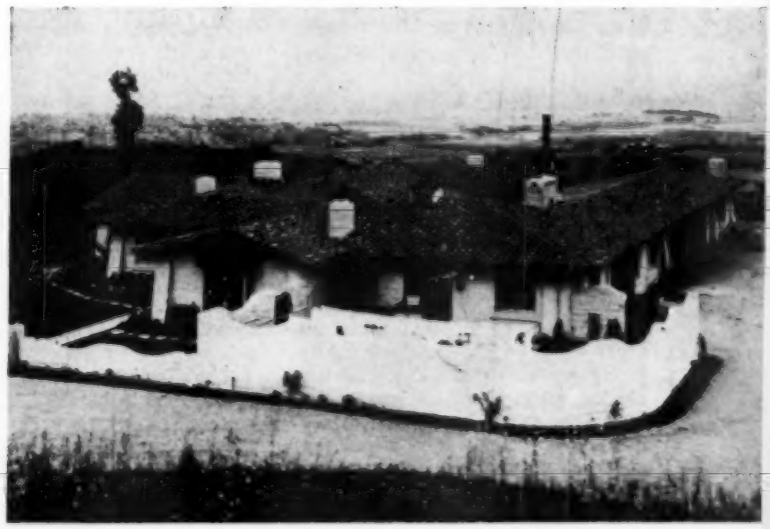
Note: Bitudobe is a product of American Bitumulus and Asphalt Co., San Francisco, Calif.

▶ Adobe brick made with emulsified asphalt adhesive has been immersed in water, as in top photo, for as long as three months without losing its strength or absorbing more than two per cent moisture.

▶ The mechanical mixer shown on the right is used to mix and cast water, soil and emulsified asphalt for modern adobe brick. Unless carefully maintained, old-fashioned adobe brick tended to disintegrate.

▶ In the photograph below, modern adobe brick is shown being laid with conventional Portland cement in much the same manner as standard brick masonry. Adobe is cast in rectangular wood frames.

▶ The modern home shown in the lower right-hand photograph contains waterproof adobe as its principal structural material. Adobe provides excellent thermal insulation and has good soundproofing qualities.



Construction and repair costs cut by

Epoxy Adhesives in Concrete

New formulations now being widely employed for road construction and repair provide for higher flexural, tensile and shear strengths as well as easier application

By R. W. GAUL and A. J. APTON

Adhesive Engineering
Division of Hiller Aircraft Corp.
San Carlos, Calif.

Epoxy adhesives for concrete bonding are now being specified by federal, state, county and city agencies for an ever-increasing number of construction applications. Architects, engineers and contractors are daily discovering new uses for these versatile and easy-to-use adhesives—in original construction as well as for repair and maintenance.

Exceptional bond strength and economy are the prime factors in the mushrooming rise of the epoxy adhesives as construction materials. They bond to concrete with strengths greater than the concrete itself. When the adhesives are used to bond concrete in highways, bridges, buildings, aircraft runways, streets, sidewalks and floors, the costs for labor and materials are frequently less than half those of conventional repair methods. And where traffic is involved, epoxy adhesives quite often can speed the return of the facility to service within several hours.

Epoxy adhesives bond equally well to both asphalt and concrete surfaces. They effectively bond new concrete to old, such as toppings to bridge decks, dams and floor slabs; build up gutter grades to proper levels; fill cracks and deep or shallow spalls; fill cracks and holes in vertical and overhead concrete; bond stone, masonry, slate, marble and other structural materials to concrete; anchor traffic bars, buttons and markers to asphalt, portland cement concrete and bituminous concrete pavements; and bond steel dowels into concrete runway slabs.

Epoxy adhesives for concrete bonding are especially formulated for extremely high flexural, tensile and shear strengths. They have excellent impact and environmental resistance, and possess an important degree of flexibility. The effective strength of the adhesive is the actual strength of the concrete since the strength of the adhesive and its bond are substantially higher than the cohesive strength of the concrete mass. Tensile strength of the adhesive when fully set varies from 200 to 700 psi, according to the concrete mix. Flexural strength for either cross-bonded or laminated beams is in the same range. Effective shear strength of an epoxy adhesive joint is 4000 to 5000 psi.

The effective impact strength of an epoxy bond is that of the entire concrete mass, even when the bonded layer is thin or feather-edged. Epoxy joints resist environmental forces commonly encountered by concrete roadways and structures. In addition to being impervious to water, gasoline, fuels, lubricating oils, most hydrocarbon solvents and de-icing salts, they can withstand freeze-thaw cycling and temperatures from minus 70° F. to well over 350° F., an important consideration.

While the adhesives are thermosetting and therefore rigid by comparison with rubbers, flexible plastics, etc., by formulation they are endowed with an important degree of flexibility which allows them to withstand shrinkage strains resulting from concrete curing. In most normal applications, they will accommodate thermal expansion and contraction throughout the considerable temperature range to which concrete structures are generally exposed.

It should be made clear that while epoxy resins have been saddled with the term "miracle plastics," there are many different types of epoxy resins, each of them designed for specific applications. No single resin will meet all engineering requirements. For example, to produce epoxy adhesives with the most desirable properties for concrete bonding, three different resins made by Shell Chemical Company—Epon® 815, 820 and 828—are combined with polysulfide resins and selected amine hardeners.

The resulting three formulations

are Concresive 1, a low viscosity fluid which can be readily applied by brush or can be sprayed with special equipment; Concresive 2, a paste which is preferable for bonding two rigid materials together since it will fill voids between the surfaces if they do not meet perfectly; and Concresive 3, a grouting compound that is less viscous than Concresive 2 and is designed for bonding shapes such as dowels which are used in concrete structures.

Two-Part Formulations

The adhesives are supplied in two parts: a resin and a hardener. These are mixed together prior to use and produce the bond as they cure through chemical reaction. To avoid waste, only as much of the adhesive is prepared as can be applied before the resin sets, usually 30 minutes to one hour.

Surfaces to be bonded must be free of contaminants and the degree of preparation required to expose clean concrete will depend upon age, prior use and exposure. Oil- or grease-impregnated concrete should be sandblasted, or etched with a diluted acid solution. After acid etching, surfaces should be flushed with water to remove residues and thoroughly dried before application of the adhesive. For ordinary sidewalk repairs, wire brushing followed by a blast of compressed air to blow away dirt and dust is usually sufficient.

New concrete applied over the epoxy adhesive should always be a relatively dry mix, standard slump value of 0 to 2½ inches. Coarse aggregate can be used except on feather-edges. For a smooth outer surface, dry-mix concrete can be covered with a wetter surfacing mix.

In areas subject to much settling, such as in gutters where true grade cannot be met by original concrete casting, or in sidewalks that have settled to a point where they are hazards, the epoxy adhesive is brushed on just before a fresh concrete grout is overlaid. This method serves to build up gutter grade to the proper levels and eliminates bird baths and depressions.

Naturally, any slab that is overlaid should be structurally sound. If the gutter is too high, the surface can be chipped down just below the desired level and then built up to a smooth surface at the desired level by bonding the new concrete to the old. When feathering concrete, a curing compound should be used to prevent too rapid a cure of the concrete.

Small cracks are sealed by either pouring or brushing in the adhesive. For wide cracks the adhesive is mixed with clean, dry sand and troweled like a mortar. The strength and the slightly flexible nature of the bonding agent are sufficient to resist load and temperature stresses, and to prevent progressive concrete failure that might otherwise occur at the cracks.

One of the major advantages of the epoxy bonding process in this type of repair is the total savings realized. Cost to re-cover a distressed concrete sidewalk by overlaying can be accomplished for at least 50 per cent less than the replacement cost of new concrete.

Cost Comparison

In most cases, repairs by bonding an overlay of concrete to a sidewalk depression will range between 30 and 50 cents/sq. ft. for areas under 100 sq. ft. By comparison, to repair a depressed sidewalk for a similar area by tearing out the concrete and replacing it with a fresh pour would cost from approximately 80 cents to $1.00/sq. ft.

At 80° F. or slightly lower, the adhesive, when applied in a thin layer over the old concrete, will remain in a tacky condition which will permit bonding of the new concrete for well over an hour. At 110° F., setting time is reduced to 30 minutes. When pavement temperatures rise to 150° F. (not uncommon in desert localities), setting time of the adhesive drops to about ten minutes. Since it would be difficult to pour concrete within this time, such work

Epoxy Adhesive in Aircraft Runway Construction

In aircraft runway at Mather Air Force Base, a new method of load distributions consists of embedding steel dowels 18 inches apart for full length of the runway.

Half of dowel is epoxy coated and inserted into precoated hole.

Depressed gutter area is raised to proper level with sand and cement mortar troweled over a surface that has been coated with epoxy adhesive.

Crack in roadway of viaduct near San Mateo, Calif., was filled with adhesive over two years ago. Other methods used previously had failed to give satisfactory results.

Left, ribbons of epoxy adhesive are brushed onto plant-mix road just before the concrete curb (see photo below) was extruded. Savings were considerable.

is usually scheduled for the morning hours in these areas.

The requirements of an epoxy resin adhesive for street repairs are high strength and a certain degree of flexibility so that the repair material gives with the pavement. This type of material has been used with much success to repair chuck holes, pot holes and deep cracks in both asphalt and concrete pavements.

Crushed granite and sand are added to the liquid adhesive to produce a grout-like material which can be troweled easily to the desired level. In cases where a road must be opened to traffic with a minimum of delay, the repairing compound can be cured in less than 30 minutes by applying heat.

Chuck hole repairs were made in this manner in July 1958 on several heavily traveled streets in Los Altos, California. Recent examination of several of those repaired sections revealed that: (a) the adhesive compound was still intact without any signs of cracking or breaking; (b) color of the pigmented bonding material matches the road so well that some of the repair patches cannot be located.

Curb Extrusions

The technique of bonding continuous concrete curb extrusions to existing roadways is still quite new. To date, most of these curbs have been laid in the West, mainly for dividing strips on both concrete and asphalt pavements. But city, county and state highway authorities throughout the country are expressing much interest in this economical technique.

Recently completed was a four-mile traffic island on the El Camino Real between Sunnyvale and Santa Clara, California. Construction of this island required a total of eight miles of the extruded concrete, the two curbs being laid eight feet apart and parallel to each other and the roadway.

The prime advantage of extruded curbing is that it costs less than half that of conventionally poured curbs. Since the only concrete needed is above the roadway, the total amount of concrete is sharply reduced. Sizable labor savings are also realized by the elimination of excavations and form set-ups.

The average national and California costs to install standard poured curbing is about $2.50/lineal foot (which on long-run jobs might drop to $2.00). However, by extruding the curbing in a steady ribbon of concrete which is bonded permanently to the existing roadway, total cost of labor and materials drops to less than $1.00/lineal foot.

Extruded curbing consists of fresh, dry and almost no-slump concrete which is extruded in final form by special machines. (Power Curbers, Inc., in Salisbury, N.C.). This method of on-the-job application eliminates the labor of pouring individual concrete curb sections plus the problems of storing and later transporting them to the job site.

Bonding the still-wet concrete to the roadway with the adhesive assures permanent anchoring of the curb despite impact by car and truck wheels.

Immediately before the concrete is extruded onto the pavement, the adhesive is brushed onto the roadway in two 1½-inch strips or in 2 single four-inch wide ribbons. These are placed at the edges of the strip onto which the ten-inch wide curb will be extruded. The adhesive is designed with a curing rate such that, once applied, there is more than enough time for the curb to be laid.

Curing time for the adhesive in this application is not regarded as a critical factor because the resin will cure more rapidly and develop strength faster than the concrete itself.

Runway For Aircraft

One of the airfield problems created by the latest Air Force bombers is that their equipment loads expose certain runway areas to unusual stress. As one solution, the Corps of Engineers in 1957 specified increases in the pavement thickness plus the use of steel dowels for load transfer in these areas. One of the first applications of the new method was made in construction of heavy-duty pavement at Mather Air Force Base. Photographs of the runway construction can be found on the facing page.

Design called for dowels of 20-inch and 24-inch lengths (depending upon pavement thickness) to be placed in 18-inch centers along the longitudinal construction joints. Half the dowel length was to be cast in one concrete slab, while the other half was to be greased so that it would be free to move in the adjoining slab. However, because of the spacing and the diameter of the dowels (extra strength pipe ran over two inches), it proved difficult to remove the forms over the dowels.

The contractor devised a solution by casting holes in the sides of the pavements to receive the dowels. He did this by bolting 10-inch and 12-inch plastic dummy dowels to the inside of the forms, and moving them after the concrete had set and forms had been lifted. The holes remaining were slightly larger than the dowel diameter, a precaution taken to eliminate the need to drive the dowels into the holes.

". . . recovering a distressed concrete sidewalk by overlaying can be accomplished for at least 50 per cent less than the replacement cost of new concrete."

A Portland cement grout was first tried to bond the dowels tightly into the holes, but there was some doubt that the grout had filled the space between dowel and the pre-cast hole. This later was confirmed upon examination of the dowels placed with grout in pre-cast holes in concrete beams.

To obviate this possibility, a new material was sought which could be applied in a fluid state; would possess sufficient viscosity to completely fill the space and not flow out from around the dowel; and yet provide adhesion between the dowel and the concrete of a strength at least equal to that of the adjacent concrete.

The need for permanent anchoring of the dowels prompted the Engineers to employ an epoxy grouting compound whose adhesive strength had been proved as suitable for bonding steel to concrete, as it was for joining concrete to concrete. Both the holes and one-half the length of the steel dowels were coated with the grouting compound and the dowels inserted into the holes. The compound was formulated to set moderately hard in 24-48 hours at 75°F. and to develop full strength in six to eight days at this temperature.

Tests performed by the Corps of Engineers were for bond strength in shear between the concrete and the dowel. Dowels were bonded in concrete beams in the same manner as used in the pavement. After the adhesive had cured, a section of the beam was sawed out. In each test the concrete was shattered without delamination of the bond of dowel to concrete. As a result of this and other studies, this method of installing dowels has been approved for use in the Corps of Engineers Contract Specification for Rigid Pavement as an alternate method of construction.

This test work was accomplished by the Sacramento District, U. S. Army Corps of Engineers, Col. A. E. McCollam, District Engineer. Technical assistance was provided by the Materials and Research Laboratory, California State Division of Highways, which has had extensive experience in the use of epoxy adhesives.

Traffic Buttons

Over two years ago, four-inch diameter traffic buttons were cast with a tough epoxy resin casting compound to California State Division of Highways specifications. The buttons were then bonded to the road surface with an epoxy adhesive to act as lane dividers on the Richmond-San Raphael Bridge, which crosses the northern arm of San Francisco Bay. Despite the daily continuous traffic of all types, the buttons have not been damaged in any way nor have they worked loose.

This record does not compare with the service life of the original experimental cast epoxy traffic buttons bonded to the roadway at two locations in California over five years ago. One is on Hanson Way in Palo Alto and the other is on the San Francisco-Oakland Bay Bridge. The edges of these particular buttons now show some wear but the buttons themselves are still firmly attached to the road.

New Program

The U. S. Corps of Engineers is testing overlays of refractory-type concrete and brick bonded to aircraft runways exposed to the high temperature exhaust of jets. Another program under consideration is renewal of old concrete runways by pumping epoxy adhesives into cracks in airfield pavements in order to restore the pavements to their original structural serviceability.

By RALPH L. McKENZIE
President, Metal Curtain Wall Division
National Association of Architectural Metal Mfrs.
Chicago, Illinois

Metal Curtain Wall Sealants

Modern formulations are designed to cope with the six basic stresses–gravity, heat, water, air, sound and light–encountered in all curtain wall construction

To keep pace with improved techniques in metal curtain wall construction, new sealants have been developed to solve many of the basic problems encountered in construction of early curtain wall buildings.

The limitations of conventional glazing compounds, used by pioneer erectors, have been overcome by more durable sealants specifically designed to cope with the basic stresses encountered in curtain wall construction. These factors include gravity, heat, water, air, sound, and light.

Gravity causes the foundation of a building to settle. As a result, the structural frame movements may exert shearing, peeling, and twisting stresses on the sealers. Although this settling is greatest during the first two years after construction, buildings continue to settle to some extent over a longer period.

Heat-Induced Stresses

Heat also causes stresses on sealants, due to resulting expansion and contraction of the structural frame.

Water, whether it originates as rain, snow, or condensation, must be kept out of the building. An effective sealant must have a low vapor-transmission rate to prevent vapor infiltration through a sealant. Expansion of freezing water that has infiltrated can cause broken lights of glass and destroy panel sealants.

Air attacks sealants in two ways—physically and chemically. A high wind can cause deflection of a curtain wall panel, and thus exert a squeezing or peeling effect on the sealer.

In addition, oxygen or other gases in air can cause certain types of sealers to either harden or deteriorate. An air tight seal is extremely important. Air infiltration can disrupt air-conditioning and heating, as well as permit infiltration of dust and dirt.

Unwanted sound can be eliminated by a well sealed curtain wall. This sound can originate from three sources (1) air leaks; (2) rattling panels; (3) street noises that enter a poorly sealed building.

Strong sunlight exerts a chemical effect upon sealants, causing some of them to lose their resilience, bleed, discolor or otherwise deteriorate. Early glazing compounds were particularly vulnerable to ultra-violet rays, and resealing was common.

Sealants designed to resist these environmental hazards are used in two basic types of joints—rigid and non-rigid. Rigid joints are bonded to form a unit, as in welding or in the use of the structural adhesives. A non-rigid joint permits movement that allows for expansion and contraction.

A number of non-rigid sealants are currently in use. Each has advantages and disadvantages, and selection is usually based upon particular job requirements. The two most widely used types are gaskets and mastic filler materials .

Gaskets in current use include soft mastic ribbons, such as polybutene ribbons and beads; resilient butyl rubber ribbons used as spacers and secondary sealers; and cured neoprene or vinyl spacers and sealing strips.

Cured neoprene or vinyl gaskets can be used either as continuous seals or as spacers for liquid sealants. They are relatively quick and easy to install. However, close tolerances must be maintained. This is sometimes difficult to obtain in curtain wall construction. In addition, these gaskets must be kept under constant compression to hold a seal. If cold flow or migration of plasticizer occurs, the seal may be lost. Positive seal of mitred corners can also be a problem.

Mastic Fillers

A second basic type of sealant consists of mastic fillers. These may be oil-based glazing compounds, polybutenes, neoprenes, polysulfides (Thiokol liquid polymers), or one of the other recently-developed synthetic polymers.

The least expensive of these mastics are the conventional drying-oil glazing compounds. However, a savings on an original material and labor cost can be offset by expense of repair or replacement. Since these compounds afford only about 10 per cent elongation after aging, some manufacturers recommend that they be used only in units not exceeding 24 inches in both dimensions.

The polybutenes are available in bulk or as extruded ribbon and bead. The bulk polybutenes are marketed in gun-grade. Ribbons are available in thicknesses from 1/16 in. up or in beads of 1/8 in. diameter or larger. All the polybutenes are comparatively inexpensive. They are easy to apply to almost any shape or size

The photograph at the top of the page shows the 39-story Tishman Building at 666 Fifth Avenue. One of New York City's most imposing curtain wall structures, it is completely air-conditioned and contains 1,124,000 square feet of rentable area.

New York's newest skyscraper is the 52-story steel and glass home of the Union Carbide Corporation. The photograph at the top-right of the page was taken during the curtain wall installation. An estimated 5000 pounds of sealant was required for the steel mullion joints alone.

Architect for the Seagram Building in New York was Ludwig Mies van der Rohe. The curtain wall, which weighs 3,200,000 pounds, consists of muntz metal panels and architectural bronze frames. The 38-story building has a 12-acre area.

joint, either with a caulking gun or by pressing into the seam with fingers.

They are particularly suitable for less critical joints, such as metal to metal, or the concealed type. However, they will not withstand repeated extension or compression of very great magnitude. The polybutenes are not recommended for exposed joints because they attract and hold dirt. They have proved valuable as bulk fillers in combination systems where polysulfide compounds provide the primary seal.

Another type of mastic—butyl ribbon sealants—is supplied preformed in correct sizes and shapes for the joint. Some are reinforced to resist stretching. Most have sufficient compressibility to permit some variation in tolerances. With sufficient compression, these sealants develop enough adhesion to seam surfaces to provide an effective seal.

However, a joint in which this type of sealing principle is used, must be designed to reasonably close tolerances in order that correct compressive forces will be uniformly applied to the sealant. Butyl ribbon sealants have been used effectively in combination with other types such as the polysulfides.

By far the most versatile and durable of the commercially available sealants are the polysulfide (Thiokol) liquid polymers. Available in gun grade, the polysulfides can be applied to seams with wide variations in tolerances. They provide aggressive adhesion to properly cleaned glass, metal, and masonry.

The polysulfides retain their flexibility, adhesion, and elongation characteristics under prolonged weathering and extreme conditions of distortion and flexing. However, they are relatively expensive and require careful mixing and application. Generally, the additional cost of polysulfide sealants is justified by their superior performance characteristics. In fact, over the long run, they are proven to be the most economical type.

Sealants other than gaskets and mastic fillers that have found limited use include covering tapes and metallic strips. Both metal and plastic tapes are available. They are used for sealing edges of panels and, sometimes, for bonding directly over butt joints. Metallic strips—thin metal or foil—are bonded directly over joints using a strong, but flexible rubber-base adhesive.

A major recent development is the commercial availability of easier-to-mix two-part polysulfide sealers in a variety of colors. Some of these sealers are buttery enough in consistency to allow simple mixing with a spatula in the shipping container for the base compound. However, it must be stressed that uniform mixing of the accelerator or curing agent throughout the base compound is essential.

Mixing devices are available for correct mixing of these ingredients in one gallon shipping containers. Larger units permit semi-continuous proportioning and mixing of materials delivered from 5-gallon pails or 55-gallon drums.

Some users have developed well-controlled mixing processes for large volume requirements. They utilize quick-freezing to arrest cure until the sealant is to be used.

One-part sealants are now being investigated in the laboratory and under field conditions. The ideal one-part compound would be a thixotropic liquid when applied, but would set within a few days at atmospheric temperature to a rubbery consistency with all of the desired characteristics of the two-part polysulfide sealer. Some one-part sealer should become commercially available within the next year.

A major contribution has been prepared as a part of the Metal Curtain Wall Manual, recently published by the Metal Curtain Wall Division, National Association of Architectural Metal Manufacturers. The Manual provides a reliable organized body of technical information to guide designers, architects, and manufacturers. It has been prepared by the Research and Development Committee of the Metal Curtain Wall Division, which has representatives from major curtain wall fabricators, major metal producers, and major suppliers of other materials that go into the construction of a curtain wall.

About the Author . . .

RALPH L. MCKENZIE designs architectural metal work for The Flour City Ornamental Iron Co., Minneapolis, Minn. A graduate of Centenary College, Shreveport, La., he has headed the Metal Curtain Wall Division of NAAMM for two years.

Epoxy for Electrical Application

The superior bonding qualities of epoxy resin compounds to a variety of materials have widened their use in electrical equipment manufacturing. In the photograph at the top of the page, for example, epoxy resin aluminum cement is being used to create an exceptionally tight seal for washers on the terminal conductors of a 75 KW electrical resistance heater.

Another factor in the growing use of general-purpose epoxy resin cements is improved packaging that makes them easier to handle. For example, the components of the Metalset A-4 used in the electrical application illustrated here are packed by Smooth-On Mfg. Co., Jersey City, N.J., in two tubes of identical size and weight. This permits simple mixing and measuring of the basic resin and the hardener. Only the precise amount required for the application on hand need be prepared.

synthetic HOT MELT adhesives

By WALTER KOPYSCINSKI, FORREST H. NORRIS and STEDMAN HERMAN
Shawinigan Resins Corporation
Springfield 1, Massachusetts

"Hot melts" are solid materials which become sufficiently fluid or tacky at elevated temperatures to be used as adhesives, coatings or binders. They have several advantages over adhesives or coatings applied as solutions or aqueous emulsions.

Essentially solid and immobile at temperatures below the flow temperature, hot melts impart excellent adhesion without requiring a porous or penetrable surface for releasing solvent or water. They have quick initial tack when molten, yet when cooled, harden rapidly with little shrinkage to give a strong bond. Toxicity and fire hazard problems associated with solvent systems are obviated; difficulties encountered when solvent or aqueous emulsion systems freeze are eliminated. In many cases, greater economy can be obtained with a hot melt system.

These features, particularly the ability to soften with heat yet solidify quickly when cooled, qualify hot melts for bonding and coating smooth surfaced materials such as foil, glassine, Mylar, cellophane and polyethylene. Excellent bonds are obtained simply by pressing a hot melt coated surface to another surface at the proper temperature.

High "melt viscosity," short "pot life" at elevated temperatures and "cold flow" sometimes associated with hot melts, can all be controlled by proper formulation.

The importance of hot melts to the adhesive user is exemplified by the mass production techniques used in today's packaging industry. Paper, foil, plastic and metal sheets are coated at rates of hundreds of feet per minute. Modern packaging machines can handle 100,000 or more units per hour. The coating or sealing operation is often the limiting rate factor.

Such high speed production requires adhesives or coatings which set rapidly, since the coated material must be ready for use or further processing immediately after being coated. There is not enough time usually to remove any solvent or water. The practically instantaneous bonding of hot melts is desirable and frequently indispensable.

Certain materials have been used as hot melts for centuries. Tar, wax, rosin and asphalt are examples of early and still widely used hot melts. The advent of synthetic resins and the use of laboratory tested principles in hot melt manufacture have quickened interest by industry. Hot melts have been "rediscovered" and their modern use is based on rapidly growing experimental programs by companies that make or use them. The situation is in many ways analogous to the "rediscovery" of the centuries' old aqueous emulsion paints and the growth of their technology.

Time-tested and widely used natural hot melts are being challenged by hot melts based on synthetic resins

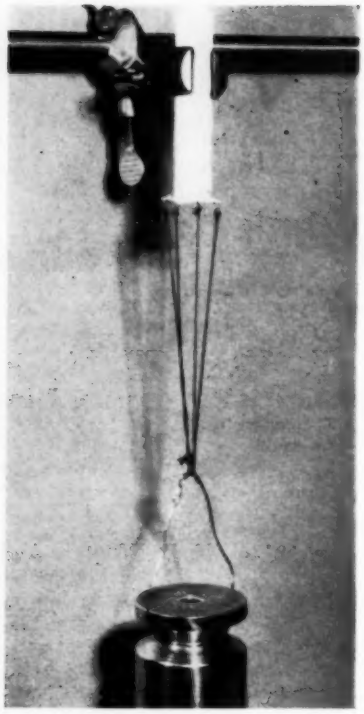
Hot melts are prepared simply by "melting" together the lower melting components and adding the higher melting components at temperatures above their melting points.

Resins, waxes, plasticizers, fluxing agents, fillers, pigments, dyes and stabilizers are typical components of modern hot melt formulations. In our thinking, the basic ingredients in a hot melt is the polymeric film-forming resin such as polyvinyl acetate or polyvinyl butyral. These resins form a tough film base when the hot melt is applied and increase adhesion of the bond.

In general, they have very high viscosities in the molten state, *i.e.*, at temperatures between 130° and 180°C. The high viscosities can be lowered greatly at these temperatures by incorporating lower molecular weight resinous "fluxing agents" such as rosin or coumarone-indene resins. Waxes and plasticizers are usually used in hot melts to impart proper flow of the coated film at temperatures suitable for heat sealing.

Plasticizers also improve flexibility and adhesion. Waxes add slip and non-blocking characteristics to the composition. Fillers and pigments are used when firmer films, opacity, color, or lower costs are desired. Antioxidants and stabilizers against the degradative effects of heat are required when the hot melts are held at elevated temperatures for extended periods.

When transparent colorless films are desired, it is necessary to have the ingredients fully compatible in the hot melt and in the film applied from it. If the components have limited compatibility, a "blending agent" must be included to obtain a clear film.



Bond strength is being tested here by suspending a weight from paper which is bonded to a standard area of a hot melt surface. Additional weight is added until the bond separates.

Certain applications require non-blocking properties. A proper balance of plasticizer and wax is necessary to get the best combination of non-blocking and flexibility. A larger proportion of a higher molecular weight grade, higher melting point resin is also used to promote non-blocking. The film-forming resins, extenders and plasticizers are chosen with attention to their adhesion to the specific surface involved.

Lowering Viscosity

The viscosity of a hot melt can be lowered to a more usable range simply by raising the temperature. This, however, may introduce problems of viscosity instability, discoloration, and eventual degradation or gelation of the hot melt. Ordinarily thin films are applied so that discoloration is not a problem. The possibility of viscosity instability or degradation limits the time that the hot melt can be safely held at elevated temperature.

Fortunately, hot melts having usable melt viscosities at practical melt temperatures are obtained when waxes, plasticizers and fluxing resins are incorporated. If relatively high melt temperatures cannot be avoided, viscosity stabilizers and antioxidants must be used.

The ultimate composition of the hot melt is determined by the adherend surface, application conditions, the manner in which the hot melt coated surface is further processed, as well as interim and final performance requirements.

The resins and modifying agents in hot melts are similar to those used in solvent adhesives, but are present in different proportions. The type and amount of the components of a hot melt are varied for each application according to the melt temperature, melt viscosity, tackiness, setting time, color, cost and other requirements imposed on it.

Film-Forming Resins—Polyvinyl acetate, polyvinyl butyral, polyvinyl alcohol, polyvinyl acetate-polyvinyl chloride copolymers, ethyl cellulose, polyethylene and natural and synthetic rubber are some of the film-forming resins used in hot melts. They give adhesion, toughness, hardness and tensile strength to the film. Their relatively high viscosity in the molten state limits the amount that can be used in proportion to other materials (compared to solvent systems where often the resin alone is the major adhesive ingredient).

Plasticizers—The plasticizer is an important component in a hot melt. It largely influences film flexibility, melt temperature, flow and tack. We consider primary plasticizers to be generally compatible with the resin over the useful range of plasticizer/resin ratio.

Primary plasticizers for polyvinyl acetate are dibutyl phthalate, Kronisol, Santicizer 8, Santicizer 140, Santicizer B-16, Santicizer 141, Pycal 94 and Resoflex 296. Primary plasticizers for polyvinyl butyral are dibutyl sebacate, butyl ricinoleate, dibutyl phthalate, Flexol 3GH and tricresyl phosphate.

Improved Viscosity Control

Secondary plasticizers have limited compatibility with the resin and are used in combination with a primary plasticizer. They are used most often to lower costs, but do confer such specific properties as toughness, resistance to plasticizer migration in the film or improved control of hot melt viscosity. Dioctyl phthalate, Aroclor 1242 and Flexol 4G0 are examples of secondary plasticizers.

Waxes—In contrast to solvent systems where the use of wax is limited, hot melts may contain a large proportion of wax. Most waxes improve the flow and spreading properties of the hot melt at lower application temperatures. The viscosity depressing effect of the waxes allows the use of resins and other components that confer special properties, but are too viscous when molten to be used alone.

Many waxes have limited compatibility with polyvinyl acetate at low, *i.e.*, normal room temperatures, and therefore, impart added "slip" and non-blocking properties. This is particularly important with hot melt coated materials, which are often wound into a roll or stacked before the coating is thoroughly cooled and are under a certain amount of pressure.

The number of waxes which can be used with polyvinyl acetate in amounts above 10 per cent is limited. Among these we have found Castorwax and Hoechst Wax to be useful. Other waxes, such as Acrawax C, Santowax, Paraflint, Crowe 23 and carnauba are used in limited amounts to impart non-blocking properties to the hot melt adhesive formulation.

Fluxing-Extending Resins — As noted previously, hot melts based on polyvinyl acetate or polyvinyl butyral can be highly viscous and difficult to apply at a practical melt temperature. In some applications the cost may be prohibitive. Fluxing-extending resins are used to overcome these drawbacks.

A few fluxing-extending resins that are used with polyvinyl acetate and, in most cases, with polyvinyl butyral are:

Rosin WW	Polypale
Resin 861	Pentalyn A
Nevillac Soft	8L Ester Gum
Nevillac Hard	Petrex Wax
Arochem 650	Santolite MHP
Gum Dammar	Hercolyn
Vinsol	Belro
Staybellite	Pentalyn G
Abalyn	

Fluxing-extending resins behave differently and are chosen according to the requirements of a particular hot melt. For example, in a bookbinding hot melt containing a polyvinyl acetate copolymer resin, Nevillac Soft (a coumarone-indene resin) gives the most heat stable hot melts. In other hot melts, Resin 861 (a modified rosin) gives excellent film clarity and a low order of color.

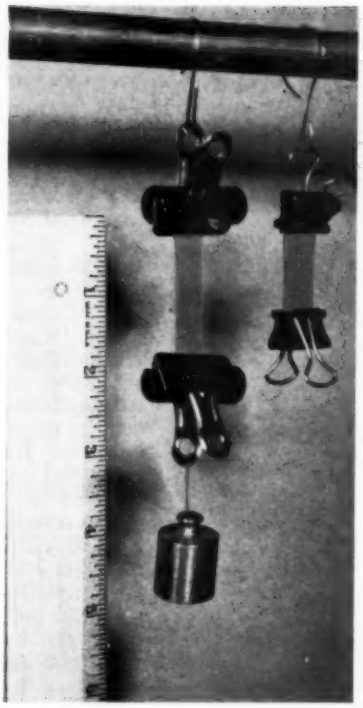
Pigments, Dyes and Fillers—Pigments, dyes and fillers may be used to obtain colored or opaque coatings, reduce costs or impart firmness. Their use is similar to that in solvent-based coatings. Some of these materials are titanium dioxide, ASP-400 Clay, and Celite.

Effects of Excessive Heating

Stabilizers—Discoloration, gelation or physical separation of the melt ingredients may occur during excessive or prolonged heating. Small quantities of stabilizers may be used to control these effects. Ionol, Catalin CAO-3, phoenothiazine, p-octylphenol, sodium benzoate, magnesium oxide, calcium stearate and sodium sebacate are used.

Extruders, kneading-type mixers, varnish kettles or other equipment providing intensive mixing and uniform heating are used to make hot melts commercially.

Extruders (single or double-screw type) are favored by manufacturers who desire to package a pelletized or rope-like product. In these forms, it is more convenient to feed to the coating machine and has a shorter remelt time. The ingredients are dry-blended, fed through a hopper into the extruder, cooled, pelletized and packaged. Extruders offer the advantage of short heating periods, which minimizes degradation and discoloration.



In elongation test, specimen on left was stretched 75% and weight removed to measure degree of recovery (normally 80%). This cold flow test is particularly important in adhesives for bookbinding.

Kneading or masticating mixers (bottom discharge or tilting bowl models) are also used. The molten mix is poured into molds of convenient size or into strippable fiber drums for shipment, or is transferred directly to application equipment.

Simple varnish kettles are adequate for making hot melts. Steel kettles equipped with slow speed stirrers fitted close to the bottom and sides are used. Dowtherm, hot oil, steam jacket or electric mantle can be used to obtain the desired temperatures, *e.g.*, 300° to 400°F., for polyvinyl acetate based hot melts. Care must be taken to avoid localized overheating in order to prevent discoloration or degradation of the product.

A typical procedure using a varnish kettle will be described. First melt together all the ingredients, except the higher melting synthetic resin(s), at a temperature slightly above the melting point of the mixture. When these are melted, add the resin gradually to avoid lumping and maintain the temperature to keep the mix fluid. After the resin has been added and completely wetted, raise the temperature to the point at which the film-forming resin will be completely melted into the composition. (This is usually the same as the eventual application temperature with polyvinyl acetate, but higher than the application temperature when polyvinyl butyral is used.)

During this final heating, agitate at a slower rate to insure a clear, bubble-free solution, *i.e.*, "de-aerate". All of the resins should be completely melted, since unmelted particles result in streaky coatings. When a uniform melt is obtained, it may be flowed directly to the coating operation or cooled in molds or pans and stored or packaged.

Hot melts can be applied with the same type of equipment used with emulsions and solutions. Roller coating is particularly effective in producing thin coatings that are relatively free of streaks and other surface defects. The two-roll coater is preferable for application of hot melts below 600 cps. viscosity at the application temperature. The three-roll coater with its hot metering roll in

About the Authors . . .

FORREST H. NORRIS is a group leader in charge of adhesives and emulsion groups. He holds a Ph.D. in physical chemistry from the University of Massachusetts.

WALTER KOPYSCINSKI is a research chemist in Shawinigan's adhesives research group. He received his B.A. in chemistry from American International College.

STEDMAN C. HERMAN was appointed technical service representative-adhesive in 1957. He holds B.S. and M.S. degrees in chemistry from the University of Connecticut.

addition to a pick-up roll and pressure roll, can handle hot melt viscosities in the 2000 cps. range. The heated gravure roll is useful in handling more viscous hot melts and gives the best control of the quantities of material applied.

Dip coating is used to apply protective coatings, as on vegetables or other food products. The entire object is immersed in the molten hot melt. It is removed and allowed to drip and harden as it is conveyed to the packaging section. The thickness of the film is determined by the melt viscosity and the temperature of the air through which the coated material travels before the coating solidifies. In the dip-transfer method, a frame or series of discs dip under the surface of the molten hot melt and, on rising, the points deposit a series of dots on the material to be bonded.

Application of protective coatings or adhesive films by knife-coating is quite effective when viscous hot melts are used. The floating knife coater is the simplest method, but gives least control of film thickness or coating weight. However, small lumps are passed through without causing streaks.

The use of spray-guns gives good control of the distribution of the hot melt adhesive or coating. Usually spraying is used with very fluid materials, but equipment for spraying more viscous hot melts is available. Spray guns are used for either spot or complete film applications. This method is useful for coating uneven or difficult to reach surfaces.

During application, hot melts must withstand a long period—up to 72 hours or longer—of heating at 300° to 400°F. without excessive degradation. Stability against degradation is shown by reasonably constant viscosity, no loss of bond strength and limited color change. New quantities of hot melt are added to the melt reservoir to maintain an adequate supply of molten material for the coating machine. Some material, however, will be held at the application temperature for long periods under normal continuous operating conditions. Small amounts of the stabilizers previously mentioned are added to prevent degradation of the ingredients under these conditions.

An indispensable part in the development of any adhesive or coating is a testing program suitable to the method of preparation and intended use of the product. Tests for such characteristics as thermal stability, viscosity and discoloration resistance are performed on the hot melt at the application temperature.

Bond strengths, water resistance, resistance to various temperatures and blocking are a few of the tests used on a hot melt adhesive or coating to assess its expected commercial performance.

A number of starting formulations have been developed and tested in our laboratory; many can be used with little further modification. Examples of hot melt adhesives and coatings based on polyvinyl acetate and polyvinyl butyral resins are given in the tables to illustrate the variety available. All components are given in parts by weight.

H-E11 is suggested as a starting point for developing hot melts which can be applied at 160° to 180°C. The plasticizer, Acrawax C and Nevillac resin are melted at 130°C. The polyvinyl acetate resin is then added and the temperature raised to and held at 160° to 180°C. until all the resin is melted. The temperature (and viscosity) can then be adjusted for proper application. The viscosity of this hot melt can be increased or decreased at application temperature by raising or lowering the ratio of polyvinyl acetate to plasticizer and fluxing agent. In addition, the choice of viscosity grade (molecular weight) of polyvinyl acetate permits adjustment of application viscosity.

Frozen food containers, beer cartons and canned goods cases are coated to increase the strength (increased water-resistance) of the container as well as for decorative purposes. H-B5 is a starting hot melt coating for packaging cartons. Hoechst Wax and Santicizer 160 are melted at 100° to 120°C. Polyvinyl acetate is added and the temperature raised to and held at 150°C. until a uniform melt is obtained.

H-B7 is an example of a hot melt that can be applied at low temperatures, 110° to 120°C. Dibutyl phthalate, Aroclor 1254 and Resin 861 are melted at 120°C. Polyvinyl acetate copolymer resin is added and the temperature held at 160°C. until a uniform melt is obtained. The temperature is lowered to 110° to 120°C. for application.

The bookbinding industry is an important outlet for hot melt adhesives that are based on alkali-soluble copolymers of vinyl acetate and monomers containing carboxyl groups. H-C1 is a basic formulation for use where recovery of scrap paper or "broke" is important. The operating temperature of the hot melt will affect the alkali-redispersibility of the resin, so it is necessary to use the more alkali-redispersible grades at higher

Table I—Hot Melts Containing Polyvinyl Acetate Resins

Designation:	*H-E11*	*H-B5*	*H-E9*	*H-B7*	*H-C1*	*H-E1*	*H-B3*
Use: / *Material*	*Basic Hot Melt*	*Protective Coating Paper*	*Paper Board Adhesive*	*Low Melting Hot Melt*	*Alkali Dispersible Adhesive*	*Coffee Cup Seams*	*Mylar to Paper Adhesive*
Gelva V-1½							1
Gelva V-7		80	50			60	1
Gelva V-15	46		50				
Gelva—C-3 V-10							
Gelva—C-5 V-16					38		
Resin 861				25			
Nevillac Soft					28.3		
Nevillac Hard	24						
Ethocel N-4						10	
Pentalyn A			100				
DBP	28		33	13	7		
Aroclor 1254				12	27		
Santicizer 8							1
Santicizer B-16						20	
Santicizer 160		20					
Hoechst Wax		20					
Acrawax C	2				1		
Sodium Benzoate					0.76		
Properties:	3000 cps. at 170°C. Non-blocking.	1000 cps. at 150°C. Flexible. Non-blocking. Heat sealable.	3000 cps. at 170°C. Non-blocking.	2000 cps. at 120°C. Non-blocking.	3500 cps. at 175°C. Non-blocking	2500 cps. at 170°C. Quick tack to PVC coated paperboard.	1000 cps. at 150°C. Permanently tacky.
RMC:	35¢/lb.	44½¢/lb.	29¢/lb.	34¢/lb.	35¢/lb.	52½¢/lb.	39½¢/lb.

Table II—Hot Melts Containing Polyvinyl Butyral Resins

Designation:	*H-E7*	*H-G1*	*H-B6*	*H-E5*	*H-E2*	*H-E3*	*H-E4*
Use: / *Material*	*Heat Seal Label Adhesive*	*Leather Adhesive*	*Low Melting Hot Melt*	*Hot Pickup Adhesive*	*Wax Paper Adhesive*	*Frozen Food Container Adhesive*	*Frozen Food Container Adhesive*
Butvar B-76		20		10	15	18	10
Butvar B-90	10		15				
Resin 861	24		43	74.4	43	25	45
Rosin WW		60					
Ethocel N-10							3
Castorwax	24	25	36	8.3	36	44	35
Armid HT	0.5	0.5	0.7	0.2	0.72	0.9	0.7
Santicizer B-16	6		3	10	4		
Dibutyl Sebacate	2						
Acrawax C					2		
TiO_2 (RA-50)						1.9	
Al-Silate W						10.4	
Properties:	1500 cps. at 150°C.	2000 cps. at 150°C.	2000 cps. at 120°C. Light colored. Slight blocking.	1000 cps. at 120°C. Quick set.	1500 cps. at 150°C.	2000 cps. at 150°C.	2000 cps. at 150°C. Non-tacky. Light colored Tough.
RMC:	36½¢/lb.	27¢/lb.	42½¢/lb.	22½¢/lb.	25¢/lb.	35¢/lb.	30¢/lb.

operating temperatures. In H-C1, Rosin WW may be used as the fluxing resin if lighter color is desired; Nevillac Soft gives lower melt viscosity. Sodium benzoate improves heat stability, while Acrawax C reduces blocking.

Quick-tack to polyvinyl chloride coated paper, water resistance at 200°F. and non-toxicity are some of the requirements of a hot melt adhesive for coffee cup seams. H-E1 is a typical hot melt starting formulation for this application.

H-B3 is an example of a hot melt adhesive having permanent tack. These latter formulations are prepared similarly to the description given for H-E11. The final melt temperatures and viscosities are indicated in Table I.

Table II gives hot melt formulations based on polyvinyl butyral for a variety of applications. The polyvinyl butyral hot melts are prepared in the same manner as those containing polyvinyl acetate except that the final melt is prepared at 30° to 50°C. higher than the application temperature indicated in Table II.

The decision to use polyvinyl acetate, polyvinyl butyral or some other resin as the basic resin component of a hot melt adhesive depends largely upon the specific adhesion of the resin to the surface in question. H-E5 is a basic starting formulation containing polyvinyl butyral resin.

An increase in polyvinyl butyral and wax is desirable for sealing wax paper; less wax and more Resin 861 is desirable for hot pick-up adhesives; less plasticizer gives coatings with reduced blocking. Other variations can be made to obtain a particular melt viscosity, melt temperature, film hardness, setting time, specific adhesion, appearance or raw material cost.

The time-tested and widely used hot melts based on wax, asphalt and natural resins are being challenged by hot melts based on synthetic resins. The latter have increased enormously the variety of applications for which hot melts can be used. Polyvinyl acetate resins and their modifications are prime examples of the kind of resin eminently suited to modern hot melt technology. Film-forming ability, inherently adhesive nature, relatively low melt temperatures, heat and light stability, film clarity and absence of taste and toxic or hazardous handling problems make polyvinyl acetate a basic component of modern hot melt formulations.

Ungummed label, above, is run through the gluer which applies a ½" strip of glue to the top and bottom. Left, the coated label is applied to the automobile window.

Chrysler uses

Price Tags That Stick

When U.S. Government regulations called for automobile manufacturers to apply a "suggested retail price label" to a side window of every car, the Systems and Procedures Department of the Chrysler Corporation set about to determine the easiest and least time-consuming method for fulfilling this requirement.

Working in conjunction with members of the traffic and purchasing departments, they called in engineers of the Glue Fast Equipment Company, New York, N.Y., a firm with a wide background and experience in the application of labels and the development of special labeling glues. Chrysler personnel explained that to avoid giving automobile dealers a removal problem when the car is sold, they wanted a label with a minimum amount of glue.

On the basis of the requirements and specifications given them, Glue Fast engineers developed a unit known as a Label-Edge-Strip-Gluer. The latter can be adjusted to apply a thin ½" strip of glue to the top and bottom of a label drawn through it. This minimum bond area is enough to keep the label firmly affixed to the automobile glass.

Because of its simplicity, the unit is inexpensive and durable. Ruggedly constructed of bronze and aluminum, the gluer consists of two components: a well for storage of glue and a set of rollers which transfers the glue from the well to the label.

The gluer can be easily adjusted so that the bondant can be applied to any part of a label by simply moving the applicator rollers to any desired position. It can also be converted to a regular full label gluer by substituting a standard roller for the strip roller.

By D. H. KAELBLE
Minnesota Mining and Mfg. Co.
Central Research Dept.
St. Paul, Minn.

PEEL ADHESION

The "zipper action" of the peel phenomenon can be either useful or destructive and requires a thorough understanding of its nature if it is to be controlled

Any adhesive joint comprising a flexible member as one of its adherends presents the possibility of peeling as a mode of failure. Peel, as a particular form of tearing, is essentially a boundary process with the physical work of peel and progressive bond destruction localized at the moving edge of the bond. It is perhaps through the analogy to tearing or failure by propagation of an incision that the "zipper" mechanism of peel becomes most apparent.

This zipper action of peel greatly reduces the force required to initiate and propagate a bond destruction process. In providing ease of unwind of a strip of self adhering tape from its roll this zipper action is an advantage. In another instance, the same zipper action of peel applied to the delamination, due to slipstream lifting forces of an adhesively bonded aircraft skin panel is most undesirable. The possible manifestation of peel as an unbonding process has, then, positive and negative results depending upon whether the bond is intended to be temporary or permanent. An adhesive joint is often influenced in both its chemical (composition of ingredients) and physical (size, shape) design with this consideration of permanence in mind. In other words, when designing an adhesive bond, shall we build in a zipper or not?

Notwithstanding the importance of peel adhesion as a circumstantial or intentionally operative mechanism of bond failure, as recently as 1951 DeBruyne wrote "a rational analysis of the peeling test has yet to be made"*(1)*. This delay in an adequate analysis of peel arises partially from the inherent complexity of the phenomena and also from the fact that a definition may not be referred to a single peel test. A consideration of the peel test amplifies this latter point.

The peel test is one of a group of approximately five common tests for bond strength. These tests are described in terms of the applied and reactive bond forces in Figure 1. The adhesive joints to which these tests are applied are described in terms of adherend deformability under the load required to accomplish the test.

Stress Distribution

Figure 1 indicates that a "tensional" test produces shearing in addition to tensional stresses. The cleavage and shear tests involve tensional, compressional, and shearing stresses. The stress distribution depends upon the physical properties of the joint components.

Since only a horizontal component of force is applied in the vertical knife test, the reaction of the bond is similar to that of stripback at an angle of 180 degrees. In a peel test where the angle of force application may vary from 0 to 180 degrees, the reaction of the bond depends upon the magnitude of the horizontal and vertical components of the applied force. At a stripping angle of 90 degrees where only the vertical component of the applied force exists, the bond stresses resemble those in the cleavage test. For all other angles between 0 and 180 degrees, a combination of shear and cleavage occurs.

Figure 1 indicates that knife and stripback tests find application where one or both of the adherends are flexible. These tests are of importance in several respects. Aside from shear testing, which is limited by the strength of the flexible member, peel or stripback tests represent the only practical method of testing bond strength. Another feature of the peel or knife test is the fact that only a small region of the bond is under high stress at any one time. Thus, a measure of the force of peel or stripping at any time is a measure of the strength of that small area of the bond under stress.

The peel rather than knife test is a more important type for several reasons. Since the force is applied to the bond in a less complicated manner, this force is a better direct measure of bond strength. Since the angle at which this force may be applied is variable, a method is available in a single test method to produce simple shear, simple cleavage, and all combinations of these. Tests of this type are valuable since they represent conditions to which the adhesive bond may be subjected in practice.

An important step toward extension and consolidation of the present numerous tests for peel could result from testing as a function of peel angle, holding rate and physical environment constant, to generate peel force (P) versus peel angle (ω) functions. It is recognition of the peel angle, the included angle between the line of action of the applied force and the plane of the bond, as an important independent variable that has resulted in the more successful recent anal-

ysis of both peel adhesion and individual peel tests.

During recent years the theoretical aspects of peel adhesion phenomena have enjoyed increasing attention*(2-10)*. The several analyses currently available treat simple one dimensional stress distributions in the vicinity of the bond boundary. From this elementary viewpoint the bond stresses are considered uniform through the thickness and across the width of the bond and variable only as a function of distance from the advancing boundary. Rather than reviewing the several somewhat parallel treatments of this subject this article attempts to summarize the high points of only one of these more recent treatments of peel adhesion*(8-10)* and to stress the utility of such analysis in designing and testing bonds involving one or more flexible adherends.

An idealized bond comprising a flexible member of thickness (2h) and width (b), an adhesive interlayer of thickness (a), and a fixed and rigid substrate is schematically presented in Figure 2. Illustrated here is the boundary region of the bond. The flexible member extending beyond the view of Figure 2 is considered to be of semi-infinite length in both the bonded and unbonded portions so that end effects may be neglected. The flexible member is assumed to be elastically deformed in both tension and bending.

In the view of Figure 2, the applied force (P) acts through a moment arm (m) at some peel angle (ω) relative to the plane of the bond. The line of action of the applied force and the central plane of the flexible member coincide at some extended distance from the bond boundary.

Two systems of bond forces are identified in Figure 2. The first of these are the tensional (f_t) and compressional (f_c) cleavage forces acting normal to the bond. The second force arrays are the shear forces (q) which act upon the lower surface of the flexible member and which are coplanar to the bond. These forces are referred to the translating (x, y) coordinate system which moves with the translating bond boundary. The stationary rigid substrate is referred to the (x_o, y_o) coordinates. The condition of steady state peel upon which this discussion is based is defined by a constant increase in a boundary displacement (Δ x) with time under a condition of constant applied force (P).

Cleavage and Stress

The general forms of the cleavage and shear stress distributions are illustrated in Figure 3. The cleavage stress (σ) and shear stress (λ) at any distance (−x) in the bond are identified with reference to their respective boundary stresses (σ_o) and λ_o).

The full equations for the cleavage and shear stress functions are summarized in Table 1. Also summarized in Table 1 are the relations defining the moment arm (m) the peel force (P) and the bond moment (M) developed in terms of the individual contributions in cleavage and shear.

Two factors (β) and (K) appear in the expression for the cleavage stress distribution. The (β) term expresses an interrelation between the bending properties of the flexible member, as represented by the Young's modulus (E) and cross-section moment of inertia ($I=2bh^3/3$), and the tensile rigidity of the adhesive interlayer as expressed by the adhesive Young's modulus (Y).

The dimensionless factor (K) determines the relation of the cleavage bond force ($P_c=P \sin \omega$) to the cleavage moment of force (M_c). The (α) term in the shear stress function relates the tensile properties of the flexible member to the shear rigidity of the interlayer as expressed by the adhesive shear modulus (G). These factors (α) and (β) have dimensions of reciprocal length and effectively operate as stress concentration factors since the practical area of significant bond stress is respectively ($2\pi b/\alpha$) in shear and ($2\pi b/\beta$) in cleavage. The zipper characteristics of our peel adhesion phenomena then depend upon four factors, the boundary stresses (σ_o) and (λ_o) and their respective stress concentration factors (β) for cleavage and (α) for shear.

From Table 1 we may develop several general relations for the peel force. The first of these is in terms of the summation of bond forces in cleavage and shear:

$$P = (P_c^2 + P_s^2)^{\frac{1}{2}}$$

$$= b\left(\left[\frac{\sigma_o(1-K)}{2\beta}\right]^2 + \left[\frac{\lambda_o}{\alpha}\right]^2\right)^{\frac{1}{2}} \quad (1$$

The second equation from Table 1, in terms of the bond moments, is:

$$M = P \cdot m = M_c + M_s$$

$$= b\left[\frac{K_o}{2\beta^2} + \frac{h_o}{\alpha}\right]$$

TEST	TYPE JOINT	SCHEMATIC OF JOINT & APPLIED FORCES	REACTION OF BONDING FORCES
SIMPLE TENSION	RIGID – RIGID		
CLEAVAGE	RIGID – RIGID		
SIMPLE SHEAR	RIGID – RIGID RIGID - FLEXIBLE FLEXIBLE-FLEXIBLE		
VERTICAL KNIFE	RIGID - FLEXIBLE		
STRIPBACK OR PEEL	RIGID - FLEXIBLE FLEXIBLE-FLEXIBLE		

Figure 1—Typical Tests for Bond Strength

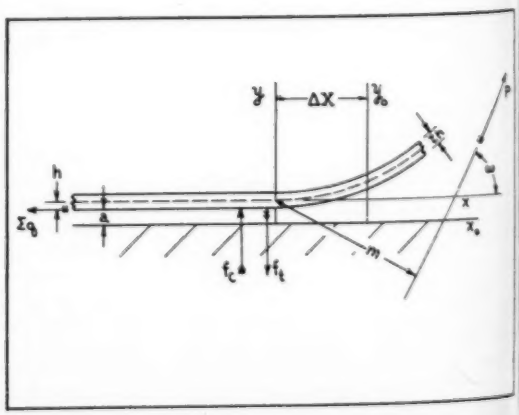


Figure 2—Bond Boundary During Peel

Table I—Summary of Equations Defining Steady State Peel

CLEAVAGE STRESS FUNCTION

$$\sigma = \frac{2\beta e^{\beta x}}{b}\left[(\beta M_c + P \sin\omega)\cos\beta x + \beta M_c \sin\beta x\right]$$

$$= \sigma_o e^{\beta x}\left[\cos\beta x + K \sin\beta x\right]$$

WHERE:

$$\beta = \left(\frac{Yb}{4EI_a}\right)^{1/4} \qquad K = \frac{\beta M_c}{\beta M_c + P \sin\omega}$$

SHEAR STRESS FUNCTION

$$\lambda = \frac{\alpha e^{\alpha x} P \cos\omega}{b}$$

$$= \lambda_o e^{\alpha x}$$

WHERE:

$$\alpha = \left(\frac{G}{2Eah}\right)^{1/2}$$

GENERAL	CLEAVAGE	SHEAR
$m = \left[\frac{2EI\,(1-\cos\omega)}{P}\right]^{1/2}$	$m_c = m - h\cos\omega$	$m_s = h\cos\omega$
$P = \left(P_c^2 + P_s^2\right)^{1/2}$	$P_c = P\sin\omega = \Sigma f_t - \Sigma f_c$ $= b\sigma_o(1-K)/2\beta$	$P_s = P\cos\omega = \Sigma q$ $= \lambda_o b/\alpha$
$M = P \cdot m = M_c + M_s$	$M_c = P \cdot m_c = \Sigma f \cdot x$ $= K b\sigma_o/2\beta^2$	$M_s = P \cdot m_s = h\cos\omega\,\Sigma q$ $= \frac{\lambda_o bh\cos\omega}{\alpha}$

Applying the general equation for the moment arm (m) into the above expression and rearranging we obtain a second relation for the peel force:

$$P = ba\left[\frac{K\sigma_o}{(2Y)^{1/2}} + \frac{3^{1/2}\cos\omega\,\lambda_o}{(2G)^{1/2}}\right]^2 (1-\cos\omega)^{-1} \quad (2)$$

Equations 1 and 2 then express the phenomena of peel in terms of the two potential mechanisms of failure discussed here. In addition we relate the peel force directly to the previously discussed basic properties of the bond.

The last consideration in our analysis of peel is concerned with the dominant stress mechanism of failure. This analysis of peel provides a relation for the ratio of boundary stress in cleavage and shear:

$$\frac{\sigma_o}{\lambda_o} = \frac{2\beta}{\alpha}\left[\frac{(m - h\cos\omega)}{\cos\omega} + \tan\omega\right] \quad (3)$$

in terms previously defined. While Equation 3 defines the interrelation between the magnitudes of the boundary stresses at any angle of peel it is the consideration of the critical stress of boundary propagation in cleavage or shear which determines the failure mechanism.

In other words, at some condition (time, temperature, etc.) of steady state peel we define a critical boundary stress characteristic of failure by cleavage (σ_{oF}) and by shear (λ_{oF}) and a critical stress ratio (σ_{oF}/λ_{oF}). If the stress ratio (σ_o/λ_o) of Equation 3 for some range of angles exceeds the ratio (σ_{oF}/λ_{oF}) defined for the bond, failure will be by cleavage. Conversely, if σ_o/λ_o from Equation 3 is less than the critical stress ratio failure will be by boundary shear. Examination of steady state peel force (P) versus peel angle (ω) functions does much to amplify and clarify this important point concerning the dominant stress mechanism.

Peel Transition

An illuminating method of demonstrating the transition in peel stress mechanism and the operation of the factors defined in Equations 1 and 2 is provided by systematic measurement of peel force with varied geometry of peel as available in changing peel angles. The steady state condition required by the analysis of peel is provided by constant rate of peel and constant temperature.

Figure 4 presents such force (P) versus angle (ω) curves for five representative self-adhering tapes. These bonds were tested at a constant rate of peel of 0.20 in./min. at 25 ± 1°C. and 50 ± 5% R.H. The various bonds are identified simply by the composition of the flexible member as follows:

Bond No.	*Flexible Member*
(1)	Glass Filament Reinforced
(2)	Cellophane
(3)	Plasticized Polyvinyl Chloride
(4)	Glass Cloth
(5)	Aluminum Foil

and the measurements apply a previously described bonding and testing procedure which provides reproducibility of both bonding and peel conditions of ± 4% of the peel force*(8)*. The common substrate for these experiments is rigidly clamped cellophane.

Plotted in conjunction to the experimental curves of Figure 4 is a highly simplified form of Equation 8 which results from assuming all factors except (P) and (ω) constant. Assuming different values for (C) shifts the entire curve uniformly along the Log P axis. The simple theoretical curve predicts a minimum peel force at ω=180° with the peel force increasing monotonically with decreased peel angle. At high angles of peel, between 90 and 180 degrees, Equation 2 takes, with fair precision, the following form:

$$P \simeq baK^2\sigma^2_{oF}/2Y(1-\cos\omega) \quad (4)$$

due to the negligible contribution of the shear stress function to the peel force. In this range of high angles the theoretical results indicate that

Figure 3A—Cleavage Stress Distribution Function

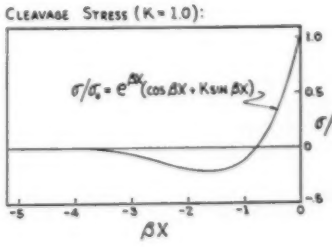


Figure 3B—Shear Stress Distribution Function

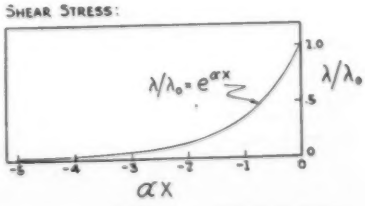
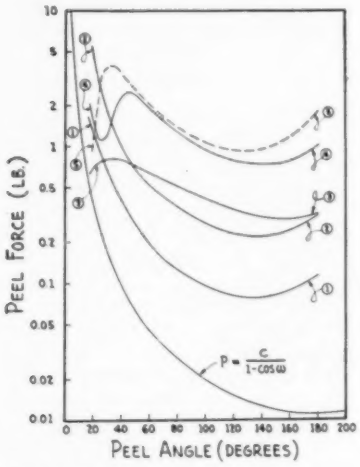


Figure 4—Comparative Effects of Peel Angle Upon Peel Force*



*For five tape bonds.

the minimum peel force exhibited by all of the experimental curves is due to a changing value of K with peel angle ω as predicted by Equation 4 while both (σ_{oF}) and (Y) are constant with peel angle.

At low angles, the dramatic falling off of peel force with decreased angle for Bonds 3, 4 and 5 of Figure 4 is evidence of a transition from cleavage to shear as the dominant stress mechanism of failure. The theoretical curves for this transition may display, maxima and minima as demonstrated by Bond 4 or simply a maximum with steadily diminishing or constant values with decreased peel angle.

Bonds 1 and 2 of Figure 4, not indicating an effect of a transition in failure mechanism from cleavage to shear, display a regular increase in peel force (P) with decreased peel angles (ω) as predicted by Equation 4. At some low angle greater than ω=0 all peel bonds undergo the transition from peel by cleavage failure to peel by shear. Inspection of Equation 3 for zero angle indicates the following relation:

$$\sigma_0 = \frac{-2h\beta}{\alpha}\lambda_{oF}$$

or that the boundary cleavage stress (σ_0) is compressive and failure must be by shear.

Design of the bond to improve shear resistance simply shifts the cleavage to shear transition to lower angles. At the limiting condition of zero angle peel, the simple equation for the peel force is from Equation 1:

$$P_{\omega=0} = \frac{b\,\lambda_{oF}}{\alpha} = \frac{b\,\lambda_{oF}}{G^{\frac{1}{2}}}(2Eah)^{\frac{1}{2}} \quad (5)$$

At the other special condition of peel at 180 degrees Equation 4 simplifies to the following form:

$$P_{\omega=180^\circ} = \frac{ba\,\sigma_{oF}^2}{4Y} \quad (6)$$

since from Table 1 the (K) term in both Equations 1 and 4 becomes unity at ω=0 and ω=180 degrees.

Failure By Cleavage

Several important facts concerning peel adhesion are illustrated by Figure 4 and this brief discussion. Where bond failure is by cleavage, as demonstrated for high angle peel in Figure 4, one may extrapolate comparative bond strength based upon peel force (P) and a common peel angle (ω) to other angles with a fair degree of confidence. A comparison of this type fails completely, however, when extended into a range where a transition to boundary shear may predominate. This latter point is illustrated in comparing the data of Figure 4 at ω=180 and ω=20 degrees.

The second very basic fact, indicated by the agreement in form of the experimental data of Figure 4 with the predictions of Equation 4, is that the cleavage boundary stress in failure is independent of the peel geometry. In other words, this property of the bond is apparently dependent only upon the conditions of the steady state in a manner very similar to a time and temperature dependent viscoelastic modulus. It is this consideration that the boundary stress defining failure propagation is a basic physical property of the bond, as are the rheological properties, that permits a rather important extension of the theory to establish the conditions for interrelation of peel rate and temperature.

Both Equation 5 expressing bond shear failure, and Equation 6, for cleavage failure, express a very basic and interesting relation between the peel force (P) and the boundary failure stress (σ_{oF} or λ_{oF}) and the modulus (Y or G). If other factors in either equation are held constant the desired peel force is achieved by a proper balance of boundary stress and adhesive modulus. Confining our discussion to peel defined by Equations 4 or 6, we may apply the following relation:

$$V = 1/t = R(\beta/2\pi) \quad (7)$$

to relate peel rate (R) to the reciprocal time (1/t) or frequency (V) of an independent rheological experiment. Equation 7 provides a new fundamental time base of cleavage peel in terms of the wave form of the cleavage stress function illustrated in Figure 3.

A now standard technique, termed the time-temperature reduced variables method, is commonly applied to superimpose modulus data from several temperatures to a so-called "master curve" characteristic of a single reference temperature(*11*). This technique is applicable to linear viscoelastic polymeric materials in a temperature range from the glass transition temperature (Tg) to (Tg + 100°C.). This treatment assumes:

(1) A change in temperature from (To) to (T) shifts the time scale of all molecular mobilities by the same factor (a_T).

(2) The magnitude of stress and modulus is proportional to absolute temperature (T).

For bonds comprising polymeric adhesive the rheological definition of time-temperature reduced variables

Figure 5A—Idealized Modulus (Y) and Cleavage Fracture Stress (σ_{oc}) Master Curves for SBR Reduced to 25° C.

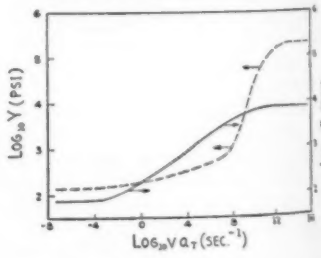


Figure 5B—Calculated Peel Force (p) for Cohesive Failure of SBR Reduced to 25° C.

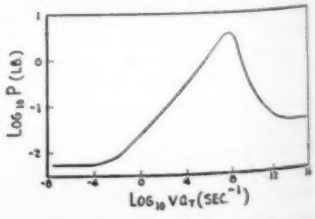


Figure 6A—Comparative Effects of Temperature Upon Peel Force*

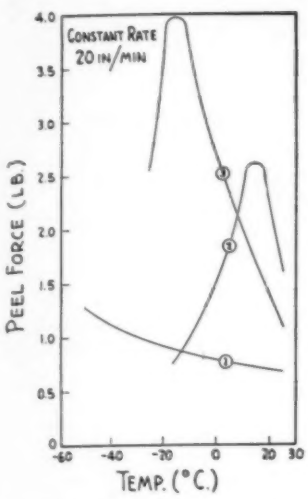
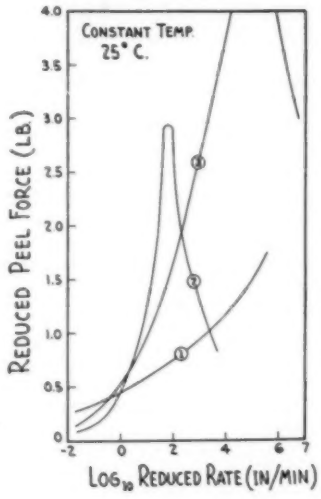


Figure 6B—Comparative Effects of Reduced Rate Upon Peel Force*



*For three pressure-sensitive tape bonds.

treatment has been applied to the basic peel parameters Y and σ_{oF} which appear in Equation 6. The successful application of this treatment to peel supports the idea that master curves may be generated which are continuous functions of cleavage boundary stress σ_{oF}, for either cohesive failure (σ_{oC}) or interfacial adhesive failure (σ_{oI}), in a manner commonly accepted for modulus properties. One of the results of the application of reduced variables to peel is the following equation:

$$P_{(Va_T,\,T_o)} = \frac{\sigma_{oF}\,(Va_T,\,T_o)}{Y_{(Va_T,\,T_o)}}\left(\frac{ba}{4}\right) \quad (8)$$

which is a re-expression of Equation 6, but where P, σ_o and Y are now referenced explicitly to a temperature reduced frequency (Va_T) and a reference temperature (T_o). Equation 8 states then that if master curves of two of these variables exist, the master curve of the third may be calculated. The second relation:

$$P_{(Va_T,\,T_o)} = \frac{T_o}{T}\,P_{(V,\,T)} \quad (9)$$

where $P_{(Va,T)}$ is the peel force at reference temperature (T_o) and frequency (Va_T) and $P_{V,T}$ is the peel force at temperature (T) and frequency (V). Equation 9 restates the previously stated two assumptions of reduced variables directly to peel force data. This equation then defines the manner in which data at any temperature (T) and frequency (V) may be referred to the desired reference temperature (T_o) and reduced frequency (Va_T).

An illustration of the application of Equation 8 is presented in Figures 5A and 5B. Figure 5A presents master functions of the boundary stress for cohesive failure (σ_{oC}) and adhesive modulus (Y) over the time range from glassy response (Va_T greater than 10^{14} sec^{-1}) to idealized rubber-like elasticity (Va_T less than 10^{-4} sec^{-1}). These curves are based on data for SBR (20 to 25 per cent bound styrene) reduced to 25°C. (*10*).

Independent of Rate

Figure 5B presents the calculated peel force master curve for 25°C. where in Equation 8 the bond width b=0.50 in. and adhesive thickness a=0.001 in. In the equilibrium rubbery range and in the glassy state the calculated peel force is independent of rate. In the transition region between this low and high ranges of (Va_T) the peel force passes through a major maximum. It may be noted that the maximum peel force occurs in a (Va_T) range where both (Y) and (σ_{oC}) are quite time dependent.

Figures 6A and 6B present peel rate and temperature dependent properties of three bonds which differ with regard to the adhesive interlayer. These three bonds:

Bond No.	*Adhesive*
1	Silicone based
2	Polyisobutylene plus tackifying resin and plasticizer
3	Natural rubber plus resin

are of normal transparent tape construction with flexible member and adhesive thicknesses of approximately 0.001 inch and 0.5 inch width. These tapes were bonded to rigidly clamped cellophane at 25°C. and peel tested at 90 degrees stripping angle and rates from 0.02 to 20 in./min. over the temperature range indicated by Figure 6A. These bonds display apparent adhesive failure so the boundary cleavage stress becomes σ_{oI} for interfacial failure. The curves of Figure 6A are plots of direct experimental results. Figure 6B presents curves which result from the reduction of data at lower temperatures and superposition to form peel force master curves characteristic of 25°C. by application of Equation 9 where we assume to a first approximation that β of Equation 7 is constant over the range of measurement.

Bonds 2 and 3 of Figures 6A and 6B exhibit a peel force maximum of the type predicted by the general form of Figure 5B. The lack of a peel force maximum for Bond 1 reflects the much lower temperature of the glassy state peculiar to this adhesive. Increasing reduced peel rate in Figure 6B is equivalent to reducing peel temperature in Figure 6A.

The result of the temperature ratio of Equation 9 is to increase the peel values at high rates in Figure 6B over those of Figure 6A as noted in comparing the maximum peel forces of Bonds 2 and 3. Consideration of the cleavage fracture stress (σ_{oF}) and adhesive modulus (Y) as they are affected by rate and temperature suggest two additional areas of application for peel theory. The first of these is designing bond adhesion properties with a foreknowledge of the effects of time and temperature that might be obtained by the curves displayed in Figure 5A. The second area involves the extension of the practical limits of testing methods as illustrated by Figure 6B. Curves 6A and 6B also demonstrate the need for caution in judging adhesion properties based upon data

About the Author . . .

D. H. KAELBLE received his chemistry degree from the University of Minnesota in 1951 and has been with the Central Research Department of 3M since. He conducts research in rheological, adhesion and physical chemical properties of high polymers. Mr. Kaelble has authored several papers on the adhesion properties of bonds involving flexible members.

obtained at a single test rate and temperature.

This brief discussion has, of course, touched on only certain high points of the phenomena of peel adhesion. An understanding of peel adhesion is complicated by the fact that two fracture processes, cleavage and shear, are available for unbonding. Changing the peel angle may and often does change the mode of unbonding from one fracture process to the other. Our bond in peel then may be described as having two "zipper" mechanisms for failure.

Characterizing either of these potential fracture processes, cleavage or shear leads to certain prime variables which may and do change with time or temperature. Assuming the adherent and flexible member properties insensitive to time and temperature, these variables appear, for high peel angles, as the adhesive modulus Y and the fracture stress σ_{oF} for cleavage failure. Analysis of these parameters indicates that at some time and temperature they exist as points on two continuous master functions which define their time and temperature dependence. This concept was discussed for cleavage failure involving polymeric adhesive interlayers. Parallel considerations operate also for the shear failure process which reduces to a similar consideration of the adhesive shear modulus (G) and fracture stress (λ_{oF}).

The theory presented in this discussion represents but one of several viewpoints concerning peel adhesion. The simplifying assumptions which permit generalization of the analysis may remove the theory and associated discussion from certain of the real and practical complexities of peel adhesion.

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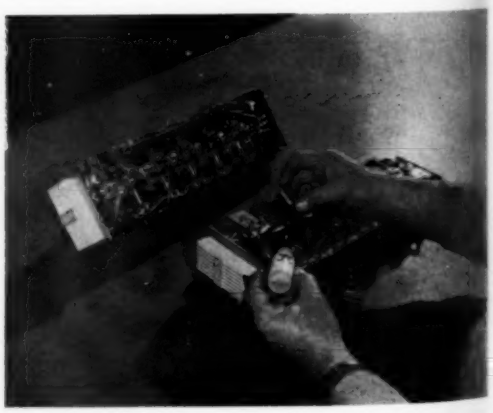
Bonding Computer Components

Substitution of a quick-setting adhesive for more conventional mounting methods is helping Electronic Associates, Inc., Long Branch, N. J., achieve greater miniaturization of electronic equipment. One particularly successful application involves bonding electrical relays to potentiometers.

Since the relay cases are made of irodite-finished aluminum, and the potentiometer covers a phenolic plastic, the problem was to find an adhesive that could provide a strong bond between these two dissimilar materials. In addition, production engineers wanted a bondant that would require no more than contact pressure, resist vibration, and cure without the necessity of catalysts, heat, or solvent-evaporation.

After considerable testing they settled on Eastman 910 Adhesive, a product of Eastman Chemical Products, Inc., New York, N. Y. It was found that under actual production line conditions a single drop of the adhesive would make an almost instant bond between the two dissimilar materials.

The relay-potentiometer units are placed in a digital attenuator system (called a DAS) which becomes part of an analog computer. By attaching each relay to its associated potentiometer and mounting the team of components as a single unit, Electronic is able to cut down on the amount of wiring necessary and to eliminate the need for relay mounting brackets.



A single drop of adhesive and contact pressure will suffice to create a strong bond between the relay and the potentiometer.

NEWS of the

ADHESIVES WORLD

Adhesives Council Meets

Panel discussion on product liability and talk by Lerner features directors' meeting held March 23-25 in New Jersey

The Rubber & Plastic Adhesive & Sealant Manufacturers Council directors' meeting held on March 24 and 25 at Cherry Hill Inn, Haddonfield, N. J., featured a panel discussion on "Products Liability." Another feature of the meeting was an address by M. E. Lerner, editor and publisher of ADHESIVES AGE, on the subject "Present and Future Potential of the Adhesives Industry."

Don Williamson (Williamson Adhesives) served as program chairman for the meeting, while H. Wesley Hibbert (Pecora) acted as moderator of the panel discussion on "Product Liability," which took place on the morning of March 25. Panel members included Edward D. Chambers (3M), George Gregory (Products Research), F. M. Jeffe (Pierce & Stevens), and J. L. Been (Rubber & Asbestos).

Among the subjects discussed by the panelists were available product liability insurance; risks covered and those excluded; the points to check or watch out for when contracting for product liability insurance, and approximate costs and how rates are determined.

Also covered by the panel were aspects which should be considered in preparing labels, literature, warranties, acknowledgments, etc., when operating under a product liability policy. Other topics covered included control procedures required; requests for plant or laboratory inspections; new products or risks; sales volume; information on prospective claims; procedures for filing claims, and company case histories and practical experiences.

It has been reported that five new companies have joined the Council: General Adhesives & Chemical Co., Nashville, Tenn.; Cycleweld Chemical Products Division, Chrysler Corp., Trenton, Mich.; Plastic Products Co., 6475 Georgia Ave., Detroit, Mich.; Templar Oil Products Co., Brooklyn, N. Y., and Howe & French, Detroit, Mich.

M. E. Lerner (center) is shown addressing the luncheon meeting of the Adhesives Council with Henry L. Dixon (Goodrich), Council president at the left, and Don Williamson (Williamson Adhesives), program chairman, at the right.

Reviews History

A luncheon followed the panel discussion and this was followed by Mr. Lerner's talk on "Present and Future Potential of the Adhesives Industry." The speaker first offered a brief review of the history of adhesives and then went on to discuss the industry in terms of size and dollar volume. Mr. Lerner estimated that the industry now enjoys a sales volume of approximately $1 billion a year and that by 1970 this figure will rise to $2 billion.

Synthetic adhesives, he stated, plus animal glues, represent some 40 per cent of the current market. The remaining 60 per cent is held by vegetable and rubber-based adhesives. Mr. Lerner estimated that by 1965, the sale of synthetic adhesives will reach 1,130,000,000 pounds. Of this total, phenolics will account for 600 million pounds; ureamelamines for 330 million pounds; vinyl, 180 million pounds, and all other types (including 5 million for epoxy adhesives) will account for 20 million pounds.

The speaker also cited unusual applications for adhesives, such as in the attachment of prosthetic parts to the human body, for structural purposes, etc. He also touched upon the field of adhesives application equipment, suggesting that the lack of suitable machinery for the proper application of adhesives is holding up new uses.

ASTM Committee D-14 on Adhesives Hold Spring Meeting at Philadelphia

Meeting features regular sessions of thirteen subcommittees; Rutzler and Marra unanimously re-elected to office by members

John E. Rutzler, Jr., Case Institute of Technology, and Alan A. Marra, University of Michigan, were unanimously re-elected chairman and vice-chairman respectively of the ASTM's Committee D-14 on Adhesives. The elections took place at the Spring Meeting of the Committee which was held at the Sheraton Hotel, Philadelphia. Penna., March 31-April 1, 1960.

At the same meeting, R. M. Kell, Battelle Memorial Institute, was elected secretary and G. S. Casebolt, American Cyanamid Co., membership secretary of the group. They succeed John J. Lamb, Radio Corp. of America, and William W. Sederlund, National Starch and Chemical Corp., who were ineligible to succeed themselves, having served two consecutive terms in office. Election to D-14 executive offices is for a two-year period.

Official Dinner Held

In addition to the regular sessions of the Committee's 13 sub-committees, the meeting at the Sheraton featured an official dinner, on the night of April 1st, at which R. P. Haviland of the Missile and Space Vehicle Department, General Electric, Philadelphia, Penna., was the principal speaker. Mr. Haviland spoke on "Materials Life and Failure."

In predicting the life, and accordingly the failure of material, Mr. Haviland pointed out, it should be recognized that the strength of a material will be determined by its largest flaw. He went on to note that any given material will have millions of flaws of a microscopic nature. By extending this theory to adhesives, he noted that higher adhesion is theoretically possible in thin adhesive films rather than thick films, since the latter will, of course, have more possible flaws.

At the regular meeting of Sub-Committee XII on Plastic Bonding Adhesives, sub-committee chairman Desmond George, National Bureau of Standards, asked that R. M. Kell, Battelle Memorial Institute, prepare a tentative test method which would enable standardization of lap shear tests for various plastic adherents. At Mr. Kell's suggestion, Tentative Test Method D-1002 for testing the strength properties of adhesives by tension loading a metal-to-metal bond will accordingly be enlarged to apply to the testing of bonded plastics as well.

"In order to accomplish this," said Mr. Kell, "it is requested that people who use this test write to me giving recommended test materials, samples, sizes, etc. These recommendations will then be incorporated in the proposed tentative method."

Information should be sent to Mr. Kell at the Rubber and Plastics Division, Battelle Memorial Institute, 505 King Avenue, Columbus 1, Ohio.

Future Meetings of Committee D-14

At a general meeting of the entire D-14 committee, announcement was made of the tentative dates set for the next seven meetings of the group. They are as follows:

Fall 1960—October 13-14, Chicago, Ill.

Spring 1961—March 23-24, Washington, D.C.

Fall 1961—October 19-20, Buffalo, N.Y.

Spring 1962—March 22-23, New York, N.Y.

Fall 1962—October 18-19, Pittsburgh, Penna.

Spring 1963—March 21-22, Boston, Mass.

Fall 1963—October 24-25, Madison, Wisc.

J. E. Rutzler, Jr.

A. A. Marra

R. M. Kell

G. S. Casebolt

Panel Talk Climax Of HPI Spring Meeting

A panel discussion, "What's What in Adhesives," was a highlight of the 19th Annual Spring Meeting of the Hardwood Plywood Institute, held March 2, 3, and 4, at the Biltmore Hotel, New York, N. Y. Presiding at the discussion was Cliff Jones of Bradley Plywood Corp. Participants were: A. B. Klinetob (Perkins Glue) who spoke on "High Frequency Gluing"; T. D. Johnson (Reichhold Chemicals) "Paper Glue Line"; A. R. Johnson (Arthur D. Little) "Air As An Extender"; R. J. Bandekow (Borden) "How and Where Does Particle Board Effect Hardwood Plywood"; and J. B. Hyman (Catalin) "Resin Quality Control and Technical Service."

The following officers were elected at the meeting: *President,* Carl D. Wheeler; *Vice-President,* Robert J. Weber; *Managing Director and Secretary-Treasurer,* Clark E. McDonald.

The board of directors approved Parkay Division of Wood-Mosaic Corp., Louisville, Ky., for membership. The board also approved a new Institute glue bond policy covering plywood grades and glue line type set forth in the proposed revisions to hardwood plywood Commercial Standard CS35, and heard a report from the Laminated Hardwood Block Flooring Committee on a boil test the Institute is recommending to the Federal Housing Administration for FHA Minimum Property Standards.

President S. M. Nickey spoke about HPI's forthcoming reminder campaign, designed to meet competition from imports and hardboard and plastics in the furniture industry.

High Frequency Gluing

In speaking on "High Frequency Gluing" at the panel discussion, Mr. Klinetob stressed three methods of radio frequency heating for gluing processes. Radio waves produced by a generator, he explained, penetrate the assembly in the same manner that they penetrate the walls of your house and are, in turn, picked up by your radio. The heat produced by radio frequency is the same as that produced by steam or electricity, and is measured in the same units of heat, the chief difference lies in the manner in which the heat is generated.

Perpendicular heating, used in making flat and curved plywood, involves placing the work between the electrodes with the glue lines parallel to the electrodes and perpendicular to the flow of energy. Parallel heating, the second method, is used for edge gluing, and the glue lines are at right angles to the electrodes. The third method, "stray field" heating, is used in cases where it is not practical to place the work between electrodes and, therefore, both electrodes are generally on the same side of the glue line. Mr. Klinetob also stressed the influence of moisture content, and the importance of uniform thickness in radio frequency gluing.

Mr. Bandekow, who spoke on "How and Where Does Particleboard Effect Hardwood Plywood?" predicted a one billion square foot mark within a few years for the particleboard industry, which now produces about 600 million square feet of 3/4 inch board per year. In mentioning three fields for particleboard, he stressed a growing market for particleboard overlayed with hardwood veneer, and also discussed a new industry standard, Commercial Standard TS-5463, applying to mat-formed, interior grade particleboard only, which has been submitted to the general trade for approval.

He dwelt on qualities necessary for good particleboard, including good glue bonding properties, and pointed to a research program being conducted by Borden Chemical Co. to develop new glues and gluing processes in this area. More than one-third of the urea formaldehyde resin used today is used in particleboard, he said, and the present growth rate is 15-20 per cent every year.

At the semi-annual sales convention of Pecora, Inc., are, left to right, first row: Laurance Bowen, Jr., William Graupner, Jack Colquhoun, William B. Bullock, H. Wesley Hibbert, William P. Werner, Al Splet, Richard C. Engelhardt. Second row: C. A. McGinnis, William Bole, Alfred Guthrie, Boris Pozniak, Glisson Wilson, Horace Garton, E. C. Moore, Robert L. Stephenson, Burt Miltenberger, Sven Neilson. Third row: James Fries, John Becker, Thomas Remmel, Carl Oster, Walter Strobel, J. R. Crowe, Wayne Waters, Chick Garton, Harper M. Tobin, Jr., Shaw Painter.

Pecora Holds Sales Convention

At the recent semi-annual sales convention of Pecora, Inc., held in Atlantic City, N.J., H. Wesley Hibbert, president, noted that company sales in 1959 had increased 15.67 per cent over 1958. Chairman of the Board William B. Bullock noted that a steady gain seems indicated for Pecora's 1960 activity. Pecora, with headquarters in Philadelphia, Penna., opened a new plant in Garland, Texas, last year. During 1959, the company introduced many new products to its line of caulking compounds, tile adhesives, asphaltic sealers, silicone water repellents, etc.

Panelists answered questions from the floor at the conclusion of talks presented during the session on Lamination of Structural Timber Beams, which was part of the Adhesives in Building program at the Spring Conferences of the Building Research Institute. The panelists are, left to right: Ward Mayer (Timber Structures); Frank J. Hanrahan (American Institute of Timber Construction); R. E. Wirth (Rilco Laminated Products); Maurice J. Rhude (Unit Structures); R. H. Bescher (Koppers Co.); Gordon Brown (Monsanto); and moderator Alan D. Freas (U.S. Forest Products Laboratory).

BRI Holds Spring Conference

Over 550 persons attended the Spring Conferences of the Building Research Institute, which was held on April 5 to 7 at the Statler-Hilton Hotel in New York City. Sixty-nine speakers participated in eight conference subject sessions. In addition to the conference on Adhesives in Buildings, at which 13 talks were presented, there were conferences on Paints and Coatings; New Building Research Proposals; Current Research in Colleges and Universities; Air Cleaning and Purification; Performance of Buildings; Insulated Masonry Cavity Walls; and Plastics Information Workshop.

George J. Schulte (Minnesota Mining & Mfg.) served as general chairman of the two-day Adhesives in Building conference, which consisted of three subject sessions: Lamination of Structural Timber Beams, *Chairman,* Frank J. Hanrahan (American Institute of Timber Construction); Bonding of Cementitious Materials, *Chairman,* Julian Panek (Thiokol); and Bonding of Gypsum Drywall Construction, *Chairman,* Thomas F. Neblett, (Gypsum Drywall Contractors International). The talks presented at these meetings were: "Structural Lamination Today," by Ward Mayer (Timber Structures); "Adhesives in Use Today," by R. H. Bescher (Koppers); "New Adhesive Needs for Structural Timber Laminating," by Maurice J. Rhude (Unit Structures); "Practical Production Testing Problems," by Ray E. Wirth (Rilco Laminated Products);

"An Architect Looks at Bonding Agents," by John H. Graham (John Hans Graham & Associates); "Bonding Materials for Interior Finishes," by Phyllis H. Larsen (Larsen Products); "The Use and Economics of Bonding Agents for Structural Applications," by John W. Davis (Lacy, Atherton & Davis); "Characteristics and Properties of Structural Bonding Agents for Cementitious Materials," by Raymond J. Schutz (Sika Chemical).

"Opportunities and Challenges in Bonding of Gypsum Drywall," by C. E. Kallem (Hollenbeck-Kallem); "Attachment of Gypsum Drywall Boards to Studs," by Alex O'Hare (Miracle Adhesives); "Lamination of Gypsum Drywall," by Rodney G. Buergin (National Gypsum); "Joint Finishing and Nail Spotting," by G. G. Waggoner (Drywall Co.); and "Future Possibilities and Research Needs," by Roger K. Humke (Minnesota Mining & Mfg.).

Lamination Session

Mr. Mayer, the first speaker at the session on Lamination of Structural Timber Beams, reviewed the current status of the structural timber laminating industry and gave a general orientation on the materials, methods, markets and future potentials of the industry.

The next speaker, Mr. Bescher, stated that the selection of an adhesive for structural laminating depends on the type of service the finished laminate will be expected to withstand. He pointed out that consideration should be given to whether the finished laminate will be in the interior of a building or exposed to exterior conditions. In addition, the adhesive should not damage or weaken the wood, but produce adhesive joints that are equal to or greater than the strength of the wood.

Mr. Rhude, the third speaker at the session, remarked that whether choosing an adhesive from the adhesive manufacturer's present list or searching for modifications to them or new adhesives, consideration must be given to the material to be bonded, the wood. He pointed out that the cellular structure of wood is responsible, to a considerable degree, for its characteristic differences as a structural material. He explained that time and temperature also play vital roles in almost all types of gluing work.

Mr. Wirth, the final speaker, discussed the three categories of the basic testing program—evaluation of raw materials; evaluation of the product; and various procedures used in a quality control program to provide surveillance and continuous control over the various steps in the process. The speaker informed the group that it is in the third category we find most of the problems and the most fertile area for improved procedures.

Following the talks, an open forum discussion was held. Alan D. Freas (U.S. Forest Products Laboratory) served as moderator of the panel which included Messrs. Hanrahan, Mayer, Bescher, Rhude, Wirth, and Gordon Brown (Monsanto).

Mr. Graham, opening speaker at the session on Bonding Cementitious Materials, covered the selection, use and performance data of bonding agents for interior finishes. He informed the audience that all architects, contractors, building owners or potential building owners should be made aware of the economic advan-

tage that may be obtained in taking into account the application of modern bonding agents in the planning, design and construction of their buildings.

The next speaker, Mrs. Larsen, remarked that bonding materials for interior finishes of the vinyl acetate emulsion type are relatively new, having been developed mainly during the last ten years. She pointed out that the rapid growth in their use by the building industry has stimulated research and development by the manufacturers to adapt their products to the new and current requirements.

Mr. Davis, the third speaker, stated that the most common and accepted use of bonding agents in building design has been in the lamination of metals, concrete, wood, insulation and other filler materials for panel construction, and bonding of various cementitious finishes to concrete or masonry structures for interior design. In discussing the economics of the use of bonding agents, Mr. Davis remarked that the limitations and safety factors which will be imposed as necessary by underwriters and building codes, as the demand for the use of bonding agents develops, will have a far greater influence on costs than is apparent at the present time.

The final session speaker, Mr. Schutz, stated that bonding agents for cementitious materials may be classified into two types: those suitable for bonding plastic concrete or mortar to hardened concrete or mortar or other structural materials; and those designed to bond hardened concrete or mortar to hardened concrete, mortar, or other rigid materials. He said that compounds have been developed which will fulfill both functions, and outlined the required characteristics of both types of bonding agents.

Bonding Gypsum Drywall

Mr. Kallem, initial speaker at the final session on Bonding of Gypsum Drywall Construction, described the growth of the gypsum drywall business. According to the speaker, the precipitous rise in prefabricated wallboard consumption is the result of communication between contractors, the gypsum association and manufacturers.

Mr. O'Hare, the second speaker on the program, stated that the best practical answer to the problem of single layer applications of gypsum drywall boards is the adhesive-nail-on system, developed to reduce the number of nails used while at the same time building a stronger wall section. The speaker also described the adhesive-nail-on method.

The next speaker, Mr. Buergin, discussed the adhesive application of a single layer of gypsum wallboard over a substrate such as exposed masonary walls and plastered ceilings and walls. He described the several types of adhesives available for laminating gypsum wallboard, including tape joint adhesive, mastic tape and contact bond.

The final session speaker, Mr. Waggoner, pointed out that the adhesives in universal use today are water soluble, air drying materials and therefore are at the mercy of the elements, namely temperature and humidity. He explained that the strength and bond of the adhesive is only achieved upon drying, and high humidity would deter drying, and freezing would, in many cases, kill the bond before the adhesive has had time to dry. Mr. Waggoner expressed the feeling that only through continued efforts of research in materials and methods in this area of joint finishing can the industry continue the progress which it has shown over the past years.

Following the talks a panel dis-

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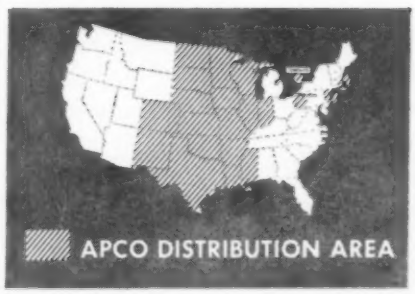

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cussion was held. Mr. Neblett served as moderator of the panel which included the four speakers and Chester E. Abbey (Bestwall-Certain-Teed), John M. King (National Association of Home Builders), John A. Robertson (U.S. Gypsum), A. T. Slosser (Armstrong Cork), and Fred Wehmer (General Adhesives Chemical).

Roger K. Humke was the final speaker at the Adhesive in Building conference. He informed the audience that it is conceivable that almost any bonding requirement of the building industry or its drywall construction operations, can be solved by the research staffs of the adhesives manufacturers, working with the virtually limitless combinations of new organic polymers which are continually being made available. He pointed out that use of these high performance products may require departures from the present building practices.

At the BRI's annual luncheon, Norman P. Mason, U.S. Housing Administrator, was awarded the newly-established F. Stuart Fitzpatrick Memorial Award in honor of his "individual contribution to the unification of the various elements of the industry."

3M Sales Up 18 Per Cent

Minnesota Mining & Manufacturing Co., St. Paul, Minn., reports that its preliminary sales figures show 1959 consolidated sales to total $445,000,000, an increase of 18 per cent over comparable 1958 consolidated sales of $376,293,016. According to the company, the consolidated sales figures include export and Canadian subsidiary sales but do not include the sales of other foreign subsidiaries.

For the first nine months of 1959, 3M reports consolidated sales of $323,079,201, compared to $271,366,401 for the like 1958 period. Earnings for the first nine months amounted to $42,583,641, equal to $2.50 per share of common stock, compared to $29,568,080, or $1.75 per share for the same period of 1958.

Appointed by Mystik

Norbert F. Hansen has been appointed marketing manager of the Industrial Division of Mystik Adhesive Products, Inc., Chicago, Ill. Formerly with an advertising agency, Mr. Hansen will be in charge of marketing, merchandising, sales promotion and advertising at Mystik.

John F. O'Brien

Joins Hysol Sales Force

John F. O'Brien has joined Hysol of California, a division of Hysol Corp., Olean, N.Y., as technical field sales representative. His sales assignments will be in the Southern California area. A graduate of Kent State University, Mr. O'Brien previously was associated with two major mid-west rubber companies.

Discusses Patents

Recent patents, as listed in the "U.S. Official Patent Gazette," involving sodium silicates are the topic discussed in the February issue of *Silicate P's & Q's*, house organ of Philadelphia Quartz Co., Philadelphia, Penna. The publication states that sodium silicate is a well-known adhesive for laminating sheet foil to paper used in cartons which protect contents against moisture or gaseous contamination. A new invention suggests a pre-coating of sodium silicate to fill the pores of the paper sheet to further decrease the absorption of air and water vapor. Molten aluminum is subsequently vaporized onto this surface. There is in addition to a mechanical bond, the possibility of chemical bond through the formation of complex silico-aluminates caused by the reaction of aluminum vapor with the sodium slicate, the publication points out.

Laminate Output Up

The Vinyl-Metal Laminators Institute of the Society of the Plastics Industry, Inc., reports that production of vinyl-metal laminates in 1959 amounted to approximately 12 million square feet, a 14 per cent increase over the previous year despite the recent steel strike.

M.I.T. Adhesive Course

An intensive course on adhesive joints will be given on June 27 to July 1 at the Massachusetts Institute of Technology in Cambridge, Mass. The four-day seminar will cover such topics as solid surfaces, wetting, application of adhesives, tackiness, setting, testing of joints, stress concentation in joints, plastic and elastic adhesives, final strength, and bulk strength. The lecturers will include university, government and industrial scientists, namely, A. G. H. Dietz, F. J. McGarry and J. J. Bikerman (M.I.T.); J. S. Arnold (Stanford Research Institute); N. Bredzs (Armour Research Foundation); R. F. Blomquist (U.S. Forest Products Laboratory); and C. A. Dahlquist and J. L. Lubkin from industry. Persons interested in attending the adhesive joint course should apply to the Office of Summer Session, Massachusetts Institute of Technology, Cambridge 39, Mass.

Conferences Scheduled

The 1960 Gordon Research Conferences will be held on June 13 to September 2, concurrently at Colby Junior College, New London, N.H.; New Hampton School, New Hampton, N.H.; and Kimball Union Academy, Meriden, N.H. The conference on "Organic Coatings," under the chairmanship of S. Gusman, will be held on August 8 to 12 at New Hampton School. The "Adhesion" conference, with Harold F. Wakefield serving as chairman, will be held on August 29 to September 2, also at New Hampton School. Information about registration and accommodations can be obtained from Dr. W. George Parks, Director, Department of Chemistry, University of Rhode Island, Kingston, R.I.

BRI Establishes Fund

A new Building Science Education Fund, to be used for the stimulation of a program for encouraging highly creative people to pursue building research activities in colleges and universities has been established by the Building Research Institute of the National Academy of Sciences-National Research Council, Washington, D. C. Milton C. Coon, Jr., BRI executive director, states that the BRI board of governors has appropriated $2,000 from Institute funds to launch this enterprise which he believes will have far reaching effects.

Chem-Etch Surface Agent

A simplified surface treatment has been developed by Chemgineers, Inc., Los Angeles, Calif., which will permit bonding of materials to Teflon and other fluorocarbon resins. A sodium solution called Chem-Etch, the agent is said to permit the typically slick surface of Teflon to be converted chemically so that adhesives will adhere to it with a high bond strength. The part to be treated is immersed in Chem-Etch from 5 to 60 seconds, and after this application the Teflon becomes brownish in color and can be bonded to itself, metals, plastics, glass, ceramics, or wood with various adhesives. The film deposit left by the surfacing agent anchors the adhesives to the Teflon. According to the manufacturer, a wide variety of common adhesives can be used, including chlorinated rubber types, resorcinol-formaldehyde cements, as well as epoxies. The company claims that the bond which exists between Teflon and the adhesive, after Chem-Etch treatment, is as strong as the Teflon itself.

Tapioca Use Increasing

A radical increase in the use of tapioca in the corrugating industry is reflected by the 1959 tapioca import figures, which are approximately double those of 1955, states John Birrell, manager of the Corrugating Department of Morningstar-Paisley, Inc., New York, N.Y. According to Mr. Birrell, the reasons for this phenomenal increase are probably two-fold. The price of tapioca is extremely favorable; and most important, there are adequate stocks of high quality and uniformity available from reliable suppliers to assure a supply of tapioca, suitable in all respects for all aspects of the corrugator's work, with consistent properties from shipment to shipment. At present, Mr. Birrell reports, the tapioca market is most favorable and shows a definite tendency to remain firm at present levels.

3M Expanding Branch

Expansion of the branch office and warehouse of Minnesota Mining and Manufacturing Company in Buffalo, N.Y., is scheduled to begin shortly. Construction, due to be completed about October 1, will include an additional 2,700 square feet of office space and 13,350 square feet of additional warehouse space. Facilities are being expanded to handle increased sales, with 1959 total sales reported exceeding half a billion dollars.

Five Named at Reichhold

In a move designed to keep pace with its rapid growth, Reichhold Chemicals, Inc., White Plains, N.Y., has appointed five new vice-presidents in four different company areas. The new vice-presidents are: Joseph E. D'Angelo, vice-president, manufacturing, Elizabeth, N.J. plant; William O. Fetterly, vice-president, manufacturing, Tuscaloosa, Ala. Division; Edward F. Kelly, vice-president, manufacturing, Chemical Color Division, Brooklyn, N.Y.; Rudolph H. Melinat, vice-president, Pacific Southern Division, Azusa, Calif.; and Thomas P. Shumaker, vice-president, sales, Tuscaloosa, Ala. Division. In his new capacity, Mr. D'Angelo will be responsible for manufacturing operations of the Elizabeth plant, while Mr. Fetterly continues as plant manager of the Tuscaloosa Division in addition to his new duties as vice-president. Mr. Kelly was formerly plant manager of the Chemical Color Division and Mr. Melinat was general manager of the Pacific Southern Division. Mr. Shumaker was general sales manager, Southern Division, before his appointment as vice-president.

Dr. W. M. Lair, previously with Wrenn Paper Co., has been appointed director of research and development of Continental-Diamond Fibre Corp., Newark, Del.

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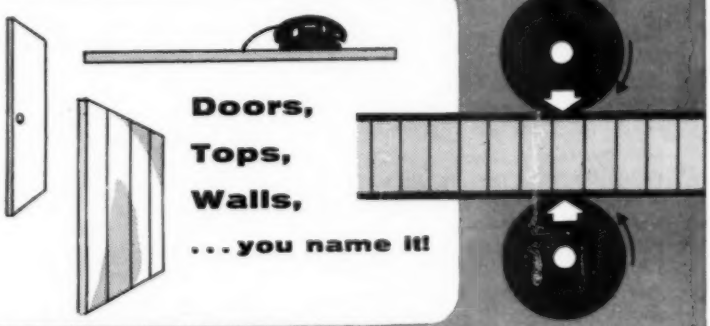

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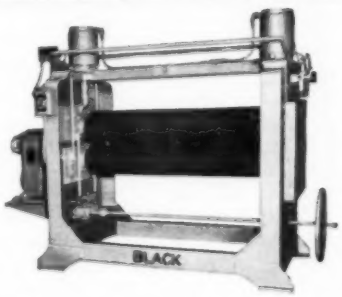

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George F. Hampl

Named Sales Manager

George F. Hampl has been named sales manager of the Industrial Adhesives Department, Armour Alliance Industries, Alliance, Ohio, to direct sales activities for compounded resin, vegetable and animal-base adhesives. Mr. Hampl, who joined Armour in 1956, was formerly sales service manager for the department. He has had wide experience in product development, plant management and direct sales of industrial adhesives.

3M May Buy Radio Net

Minnesota Mining & Manufacturing Co., St. Paul, Minn., may buy an interest in the Mutual Broadcasting System. A company spokesman reports that Mutual representatives approached 3M and the company is giving the offer consideration. Since 3M manufactures adhesives, abrasives and coatings, a tie-up with Mutual would represent a new interest for the company. Mutual owns no radio stations, but supplies news, sports and special programming to approximately 50 affiliates.

Borden Plans Expansion

Borden Company has slated a more than $1 million expansion for its Springfield, Ore. thermosetting adhesives plant. Additions, to be completed by the middle of 1961, will include a product development laboratory and a dry adhesives plant with a 10 million pound annual capacity. Present synthetic resin and formaldehyde production facilities will be expanded. Most of the Springfield plant's production is designed for the local forest products industry.

Celebrates Anniversary

Chas. L. Huisking & Co., Inc., New York, N.Y., celebrated its fiftieth anniversary in the chemical industry on January 1, 1960, by announcing a broad product development program for the coming year. A long time importer-exporter and distributor of drugs and chemicals, the firm has recently begun producing specialty products, such as monomethylol dimethyl hydantoin and dimethyl hydantoin formaldehyde resin for the adhesives market.

These and other industrial chemicals are manufactured by Huisking's Glyco Chemicals Division plant at Williamsport, Penna., acquired as a subsidiary in 1958. During the past year, over $500,000 has been invested in new plant facilities and 50 per cent more space added for research and development activities. Research is being focused on derivatives of both hydrogen cyanide and ethylene oxide.

The company was founded in a small office at 5 Platt Street, New York City, by Charles L. Huisking who thereby became the youngest drug broker in the U.S. at 25. It is now headed by his son, William W. Huisking.

Record Sales for Carwin

Record sales in 1959 representing a 30 per cent increase over 1958 were reported by Carwin Co., North Haven, Conn., in its annual report to stockholders. In addition, 1959 earnings were nearly double the previous year. Net sales in 1959 totaled $2,976,742, compared with $2,279,905 in 1958. Consolidated net earnings in 1959, after federal, state and municipal taxes, amounted to $90,067, equal to 51¢ per share of common stock, compared with $50,411, or 28¢ per share for the 1958 fiscal year. The company's financial position was strengthened by a successful $500,000 equity financing during 1959, and by negotiation of a 12-year $750,000 loan agreement with Phoenix Mutual Life Insurance Co., Carwin states.

DuPont Building Unit

E. I. du Pont de Nemours & Co., Inc., Wilmington, Del., is building facilities for production of Budium polydutadiene interior coatings for food and beverage cans at its finishes plant in Fort Madison, Iowa. The new unit is being built by the Engineering Department of DuPont, and is scheduled to go on stream by mid-1961.

George J. Teplansky

Joins St. Clair Rubber

George J. Teplansky has been named assistant to the president of the St. Clair Rubber Company, Detroit, Mich. In his post he will have major responsibility in all phases and operations of the business. He was previously vice-president in charge of operations of the International Molded Plastics Co., Cleveland, Ohio. The St. Clair Rubber Company manufactures adhesives coated fabrics and molded rubber products.

ASTM Issues Supplements

The American Society for Testing Materials, Philadelphia, Penna., has issued 1959 Supplements to its 1958 Book of ASTM Standards. Each part-supplement brings up-to-date the corresponding part of the 1958 Book of Standards by including new standards and revisions adopted in 1959. Part 6 on Wood, Paper, Shipping Containers, Adhesives, Cellulose, Leather, Casein consists of 142 pages and includes 20 standards for wood, wood preservatives, paper and paperboard, shipping containers, cellulose, leather and casein.

FMC Opens Center

Food Machinery and Chemical Corp., New York, N.Y., has opened and completely staffed its recently completed Chemical Research & Development Center in Princeton, N.J. In addition to research personnel, the center houses inorganic product application and sales service groups formerly associated with its Becco Chemical, Chlor-Alkali and Mineral Products Divisions, as well as its Chemical Patent Department. A unique feature of the center is its specially designed pilot scale areas for studies in many fields.

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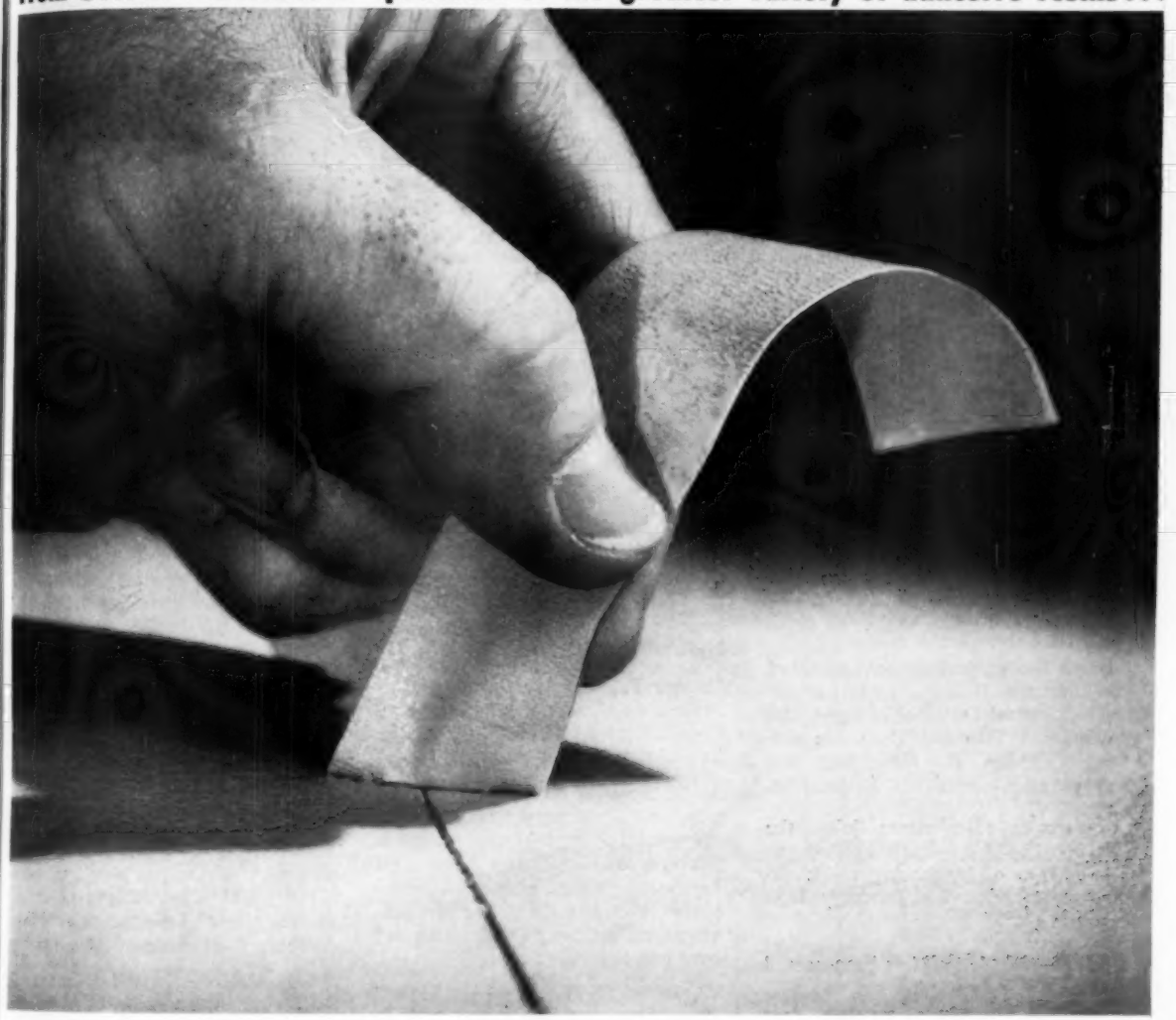

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names in the news

Robert Charbonneau has been appointed research supervisor and **Frank Bilanin** has been named product development supervisor in the Irvington Division of Minnesota Mining & Mfg. Co., St. Paul, Minn.

Robert O. Ness has been appointed sales representative of the Chemical Division of General Mills, Kankakee, Ill.

Philip D. Raths has been named manager of the new Minnesota Mining and Manufacturing chemical plant under construction at Decatur, Ala. **William H. Fuhr** succeeds him in the post of manager of the chemical plant at Copley, Ohio.

Ralph Bloom, Jr. has been appointed Washington D.C. representative for the Chemical Divisions of Food Machinery & Chemical Corp. He succeeds **Philip H. Groggins,** now senior scientific adviser, in the post.

Robert D. Dexheimer joins the Richardson Co. where he will be in charge of laminating resins development. He was formerly with Pelron Corp.

John D. McConnell has been named research chemist in the Organic Coatings Division of Battelle Memorial Institute, Columbus, Ohio. He was with Kerr Chemical.

Donald O. McCarthy has been named assistant production manager for Petrothene polyethylene resins, at U.S. Industrial Chemicals.

J. Stanley Miller has joined Armour Industrial Chemical as derivative sales representative in east central states, with headquarters at Philadelphia, Penna.

Michael G. Caparon has been promoted to the post of manager of the Advertising Department of Dobeckmun Co., Cleveland, Ohio.

G. J. Pyle has been named manager of sales promotion and new products development in the Marketing Department of the Industrial Tape Division of Minnesota Mining & Manufacturing Co., St. Paul, Minn.

Earl H. Schrader has been named manager of its Kansas City, Mo., industrial products sales office by A. E. Staley Mfg. Co.

W. L. Davis, president of Hankins Container Division of Flintkote Co., New York, N. Y., has been appointed a vice-president of Flintkote.

Jerome J. Kipnees has joined Atlantic Gummed Paper Corp., Brooklyn, N. Y., as vice-president in charge of package engineering.

Winthrop L. Carter, Jr., William E. Conway, Robert C. Dale, William H. Foster and Ross G. Smith, Jr., have been elected vice-presidents of Nashua Corp., Nashua, N. H.

George F. Murphy, formerly with Minnesota Mining & Manufacturing Co., has joined Flint Ink Corp., as its Chicago district manager.

A. M. Browne has been appointed sales and development manager for the food industry in the Materials Division of Armstrong Cork Co., Lancaster, Penna., and **B. M. Humphries** becomes assistant sales development manager for the beer and beverage industries.

W. R. McClellan has been elected vice-president of operations of Food Machinery and Chemical International, San Jose, Calif.

E. R. Davis has been appointed manager of the special projects laboratory of the Container & Chemical Specialties Division of Dewey and Almy Chemical Division, Cambridge, Mass.

C. M. Skinner, general manager of the Factory Operations Division of Sherwin-Williams Co. of Canada, has retired after 40 years of service.

R. B. Jamison has been appointed national director of sales for the Eastern Division of H. B. Fuller Co., St. Paul, Minn.

Harry Bull, packaging coordinator of Dow Chemical Co., Midland, Mich., has been named "Packaging Man of the Year" by the Packaging Society of Michigan State University.

Charles F. Peterson

Named Manager

Charles F. Peterson has joined Dewey and Almy Chemical Division as manager of organic chemicals, Western Division. Mr. Peterson, with headquarters in Los Angeles, Calif., will be in charge of sales of the firm's vinyl acetate polymers and copolymers, butadiene-styrene latices, plasticizers and dispersing agents, serving the adhesive, paint, paper, rubber and textile industries in 11 western states. A graduate of the University of Michigan in 1937, he previously was associated with Carrier Corp., General Electric Co., and U.S. Steel Corp.

Benedict Latizia has been appointed a technical sales representative in the Cincinnati, Ohio, office of Union Carbide Plastics Co.

Philip Kaufman has been named assistant chief engineer at Specialty Resins Co., Lynwood, Calif.

Dale F. Fink has joined Shell Development Co., Emeryville, Calif., as research supervisor at the research center.

Dr. John F. Gall has been appointed manager of the newly-formed Research and Products Department of Pennsalt Chemicals Corp., Wayne, Penna.

Hubert O. Ranger has been named director of the packaging laboratory at the Tarrytown, N. Y., research center of General Foods.

Lt. Gen. James M. Gavin (U.S.A.-Ret.) has been elected president of Arthur D. Little, Inc., Cambridge, Mass.

Drs. Walter Brooks and **Robert N. Johnson** have been named senior development chemists at Specialty Resins Co., Lynwood, Calif.

3M Expanding Overseas

Minnesota Mining & Manufacturing Co., St. Paul, Minn., is looking forward to further good growth of its overseas sales and production. The company noted in its 1959 annual report that the rapid expansion of its operations abroad since its direct entrance into world markets nine years ago continued during 1959. According to 3M, its subsidiaries in Europe are located in areas where the anticipated growth rate is somewhat in excess of that experienced in domestic operations. A large portion of 3M's foreign earnings in 1959 were retained to provide the capital necessary for growth requirements, although the cash received from foreign operations during 1959 substantially exceeded cash received during the previous year. It is expected that capital expenditures in the foreign field during 1960 will approximate $6 million, of which approximately two-thirds will be financed from retained earnings of the foreign subsidiaries, the company states. At the year-end there were 14 3M manufacturing plants operating in 10 foreign countries. The company reports that sales from foreign operations in 1959, exclusive of Canadian results, amounted to $95 million at current exchange rates, compared with $79.9 million a year earlire.

Furane Adds Trainees

Furane Plastics, Los Angeles, Calif., has initiated a trainee program with the addition of four new university graduates to its sales staff. The four, who have degrees in business administration and two or more years experience in industry, are: Joseph M. Hentz, John D. Thomson, Patrick B. Gallagher and J. Allen Havens. They are expected to qualify as sales engineers, receiving their training by spending time in the laboratory, manufacturing and quality control areas, and later teaming up with senior sales representatives to observe the application of epoxy materials.

Carwin Building Plant

Carwin Co., North Haven, Conn., is building a new plant at LaPorte, Texas, that will more than double its existing capacity for isocyanates. The new facility is expected to be completed in the latter half of 1960, and its chemicals will be used as raw materials for adhesives, coatings, drugs, plastics, rubber, and waterproof treatments for wood, cloth and paper, the company states.

M&C Develops Attagel 30

A new, low-cost grade of colloidal attapulgite designed to counteract the viscosity breakdown inherent in starch corrugating adhesives has been developed by Minerals & Chemicals Corp. of America, Menlo Park, N.J. Called Attagel 30, the material increases in viscosity under the action of shear forces as in the recirculation systems used in corrugated production processes. According to the company, in field tests Attagel 30 has reduced adhesive consumption by as much as 20 per cent. Other operating advantages attributed to its use on corrugating lines have been the elimination of flooding, increased operating speed, reduced frequency of glue-roll adjustments and improved bond due to better penetration and a spreading of properties on highly sized board, the company states.

Two Promoted at Staley

Two new assistant branch managers, Alfred W. Brunlieb and Donald M. Baldwin, have been named by the A. E. Staley Manufacturing Co., Decatur, Ill. Mr. Brunlieb, who will be located at the Cleveland Ohio, office, has been assistant manager of the company's St. Louis, Mo., office for the past two years. With Staley since 1952, he was named a senior sales representative in 1953. Mr. Baldwin, who will be in St. Louis, has been a senior industrial sales representative in the Kansas City territory since 1955. He joined the company in 1951 as an industrial sales drug and chemical products representative, later serving as a technical sales representative.

Reichhold Acquires Firm

Reichhold Chemicals, Inc. of White Plains, N.Y., has completed the acquisition of the Alsynite Co. of America for an undisclosed number of shares of Reichhold common stock. Reichhold will operate its new acquisition as its Alsynite Division. The division will continue to be engaged in the manufacture and sale of plastic panels reinforced with glass fiber mat, and other building and construction products and material. The new division included the Alsynite Co. of California, Alsynite Co. of Ohio, Alsynite Co. of New Jersey, the Everlite Corp., Plastikool Awning Corp., and the Ray-O-Lite Corp. of America.

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Promoted at Morningstar

Thomas W. Morningstar has been elected executive vice-president by the board of directors of Morningstar-Paisley, New York, N. Y., while David Bookshester has been named sales manager of the company's Adhesive Division. Iven G. Nichol and Joseph C. Hotton have been appointed sales manager, national accounts, and engineer in charge of machinery service, respectively. Mr. Morningstar had been vice-president and general manager of the M-P Gum and Technical Products Department, formed last year to provide expanded sales and technical service. He will continue with this work, also working closely with Murray Stempel, president, on the firm's expansion program.

Mr. Bookshester, now Mid-Western sales manager, with headquarters at the Chicago plant, will also direct sales of adhesives and related chemical products throughout the country. Mr. Nichol, now sales manager, national accounts, will direct technical and sales relationships with adhesives users operating branch plants. Mr. Hotton will coordinate the work of Sales and Technical Departments with machinery manufacturers and their customers. New to the company, he was formerly with the F. B. Redington Company.

Thomas W. Morningstar

Papercraft Buys LePage's

LePage's Division of Johnson & Johnson, Inc., has been sold to the Papercraft Corp. of Pittsburgh, Penna., for an undisclosed amount of cash. In the "multi-million" dollar transaction, Papercraft acquired the division as part of a long range program aimed at a complete line of consumer packaging products. LePage's manufactures cellophane tape and adhesives for home and office use. Papercraft recently constructed a pressure-sensitive tape unit at its plant in Jeannette, Penna. Papercraft officers noted that the acquisition of LePage's will make the company's combined pressure-sensitive tape facilities among the largest in the industry.

Polyvinyl Expanding

Polyvinyl Chemicals, Inc., Peabody, Mass., has completed an expansion program that has added 5,000 square feet to its laboratory and administrative facilities. Included in the expanded laboratory is a new polymer pilot plant. The company recently completed an expansion of its polymer emulsion plant, adding 20 million pounds to plant capacity.

SPI Western Meeting

Virtually the whole broad range of the plastics industry was covered at the annual Western Section Conference of the Society of the Plastics Industry, on April 6 to 9 at the Hotel Riviera in Palm Springs, Calif. Over 1,000 persons attended the event and heard experts in the industry talk on their specialties. Among the topics discussed during the four-day meeting were plastics in ordnance; plastics in the metals industry; plastics in boat building; business problems in the plastics industry; plastics developments overseas and their impact on U.S. markets; new technical developments; plastics in aircraft and missiles; and technical plastics education. James Watt (Monsanto Chemical) served as general chairman of the conference.

Flintkote To Buy Firm

Flintkote Co., New York, N.Y., is planning to purchase the firm of Harry T. Campbell Sons' Corp., Baltimore, Md., a producer of concrete, limestone, sand and gravel. Flintkote reports that it plans to acquire the Baltimore firm through an exchange of stock valued at about $10 million.

Food Additives Extensions

Philip O. Deitsch, managing director of the Gummed Industries Association, in a statement referring to products manufactured by the gumming industry and their applicability under the Food Additives Amendment of 1958, reports that major components of gummed tapes and labels have received either a one-year extension from the Food and Drug Administration, or will come under the "generally recognized as safe" category. Mr. Deitsch's statement is based on the FDA's extension orders of February 19 and March 7, and proposed "safe" list of February 19. These lists, Mr. Deitsch states, reflect information developed through investigation programs of suppliers to the gumming industry and contain specific reference to components of the various glues and adhesives used by members of the gumming industry.

At the same time, the Adhesive Manufacturers Association released the following statement through Kenyon Loomis, its executive secretary:

"In view of the over-all extension order received (171 substances definitely extended, 19 temporarily extended), the adhesives industry can now state that its products contain materials which have either been cleared or extended for one year. In the meantime, the industry's technical and scientific personnel are working with suppliers, Syracuse University and FDA officials to work out an over-all program covering the extended materials with the expectation that most, if not all will be cleared by March 6, 1961."

Skid-Not Coating

Adhesive Products Corp., New York, N.Y., has developed a new palletizing non-skid coating for bags, beer cases, grocery cartons and other containers. Called Skid-Not, it is a highly concentrated liquid coating which can be diluted infinitely with water and sprayed directly on the container. The amount of skid-proofing is controlled by the amount of water added. When dry, Skid-Not forms a non-skid surface which permits stacking and handling of bags and cartons without fear of sliding, the company states. Although Skid-Not can be diluted with water it is said to be waterproof and oil-resistant when dry, and imparts these qualities to the surface on which it is applied.

Adhesives At ASME Show

Adhesives, coatings and finishes will be on display at the 1960 Design Engineering Show on May 23 to 26 at the New York Coliseum, New York City. The exhibition and concurrent conference is being sponsored by the Machine Design Division of the American Society of Mechanical Engineers. More than 400 manufacturers will show their products in such categories as mechanical components, power transmission equipment, electrical and electronic components, metals, fasteners and adhesives, finishes and coatings, and engineering equipment and services. The eight technical sessions of the conference will cover such topics as: new horizons in engineering design; reliability; fabrication; hydraulics; control systems; materials; and automation.

Firms displaying their lines of adhesives, finishes and coatings include: American Sealants Co., Hartford, Conn.; Eastman Chemical Products, Inc., Kingsport, Tenn.; H. B. Fuller Co., St. Paul, Minn.; Minnesota Mining & Manufacturing Co., St. Paul, Minn.; Permacel, New Brunswick, N. J.; Raybestos-Manhattan, Inc., Stratford, Conn.; United Shoe Machinery Corp., Boston, Mass.; Avery Label Co., Monrovia, Calif.; Columbus Coated Fabrics Corp., Columbus, Ohio; and Dobeckmun Co., Cleveland, Ohio.

Container Group Formed

The formation of an Industrial Container Institute has been announced by the Society of the Plastics Institute, Inc., New York, N.Y. The new group will be concerned with plastic containers of one-gallon capacity and larger, and includes manufacturers representing approximately 95 per cent of all industrial plastic containers in the country. Jerome S. Heisler, vice-president of the Delaware Barrel & Drum Co. of Wilmington, Del., has been elected chairman of the Institute.

Holmes Joins Armour

Keith Holmes has joined the Armour Industrial Chemical Co. as Eastern Canadian sales representative with headquarters at the new Armour sales office in Montreal, Que., Canada. Mr. Holmes, an active member of the Chemical Institute of Canada, was formerly with the Films Division of DuPont of Canada. He received his B.Sc. degree in chemistry from the University of Dubuque in 1955.

3M Installs Intercom

A pushbutton communications system linking 43 plants, laboratories and branch sales offices in 17 states has been placed in operation by Minnesota Mining & Manufacturing Co., St. Paul, Minn. According to the company, the new inter-communication system speeds transmission of messages and orders and means a further improvement in service to its customers. Messages and special orders that cannot be filled at once from branch office stock are encoded on perforated tape and fed into the teletype system. At the 3M communications center in St. Paul, pushbutton equipment routes each message to its destination. Special teletypewriters automatically type each order in page form, ready for processing. All messages are automatically numbered and are recorded to speed bookkeeping. The company reports that initially, the message center is handling some 2,600 orders and messages a day on 13 circuits, and the system can be expanded as needed to as many as 125 circuits, each serving up to eight stations. The communications system uses some 10,000 miles of leased telegraphy wires and equipment developed by Western Union.

MCA Holds Conference

The Manufacturing Chemists' Association, Inc., Washington, D. C., held its semi-annual meeting and midyear conference on November 24 at the Statler Hilton Hotel in New York City. The theme of the meeting was "Building—A Major Market for Plastics." Three authorities on various aspects of the theme were the principal speakers. They were: William H. Scheick (Timber Engineering Co.) who discussed "Characteristics of the Building Industry"; William B. Tabler (American Institute of Architects) who spoke on "Building Code Obstacles"; and David P. Reynolds (Reynolds Metal Co.) who discussed "How to Market a New Building Material."

Tappi Testing Meeting

The Eleventh Annual Testing Conference, sponsored by the Technical Association of the Pulp and Paper Industry, will be held on September 27 to 29, 1960, at the Pantlind Hotel, Grand Rapids, Mich. The conference will consist of four half-day technical sessions featuring a symposium on "Relative Humidity and Paper Test Methods." The symposium will be jointly sponsored by ASTM Committee D-6 on Paper and Paper Products, and the Tappi Testing Division.

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May 1-7. National Association of Architectural Metal Manufacturers, 22nd Annual Convention, Boca Raton Hotel, Boca Raton, Fla.

May 2-3. American Standards Association, Company Member Conference, Sheraton Hotel, Philadelphia, Penna.

May 9-12. Instrument Society of America, Summer Instrument Automation Conference & Exhibit, Civic Auditorium, San Francisco, Calif.

May 11-13. American Material Handling Society, Western Regional Material Handling Show and Packaging Cavalcade, Great Western Exhibit Center, Los Angeles, Calif.

May 15-18. International Distribution Congress and Business Aids Show, 25th Annual Meeting, Statler Hilton Hotel, Buffalo, N.Y.

May 16-17. Chemical Specialties Manufacturers Association, 46th Midyear Meeting, Drake Hotel, Chicago, Ill.

May 16-17. Chemical Market Research Association, Annual Meeting, Hotel Biltmore, New York, N.Y.

May 17-19. American Society of Mechanical Engineers, Production Engineering Conference, Hotel Schroeder, Milwaukee, Wisc.

May 18-20. Society for Experimental Stress Analysis, Spring Meeting, Hotel Severin, Indianapolis, Ind.

May 19. Symposium on Plastics in the Sixties, Sponsored by Quantum, Inc., Yankee Silversmith Inn, Wallingford, Conn.

May 23-25. TAPPI 11th Coating Conference, Edgewater Beach Hotel, Chicago, Ill.

May 23-26. American Society of Mechanical Engineers, Design Engineering Conference & Show, Statler Hilton Hotel, New York, N.Y.

May 23-28. Instruments, Electronics and Automation Exhibition, London, England.

June 1-3. Instrument Society of America, 6th Annual Instrumental Methods of Analysis Symposium, Montreal, Quebec, Canada.

June 1-10. International Chemical Exhibition, Belgrade, Yugoslovia.

June 3-12. International Trade Fair, Expo Oresund, Helsingborg, Sweden.

June 5-9. American Society of Mechanical Engineers, Annual Meeting and Aviation Conference, Statler Hilton Hotel, Dallas, Texas.

June 5-9. Forests Products Research Society, 14th National Meeting, Montreal, Quebec, Canada.

June 5-9. Society of the Plastics Industry, 9th National Plastics Exposition and Conference, New York, N.Y.

June 5-9. World Power Conference, Madrid, Spain.

June 6-8. American Material Handling Society, New England Show, Commonwealth Armory, Boston, Mass.

June 6-9. New Coatings and Coatings Raw Materials Symposium, Coatings Technology Department, North Dakota Agricultural College, Fargo, N.D.

June 9-11. Manufacturing Chemists' Association, 88th Annual Meeting, Greenbrier, White Sulphur Springs, West Va.

June 10-26. Federation of British Industries Exhibition, New York Coliseum, New York, N.Y.

June 13-15. 43rd Annual Conference and Exhibition of the Chemical Institute of Canada, Chateau Laurier Hotel, Ottawa, Ontario, Canada.

June 18-26. Plastics Industries Exhibition, Europlastica 60, Ghent, Belgium.

Portrait Of

ALAN A. MARRA

Recently re-elected to his second two-year term as vice-chairman of ASTM's D-14 Committee on Adhesives, Alan A. Marra is an associate professor of wood technology at the University of Michigan's School of Natural Resources. In addition to his teaching duties, Dr. Marra acts in the capacity of research coordinator for his department. His activities range from work in fundamental mechanisms of bond formation on wood surfaces to gluing processes and production problems.

"One of our most important shortcomings in the wood gluing field," Dr. Marra points out, "is lack of specific knowledge about wood and the condition of its surface with respect to gluing. . . . Much of my current work is aimed at creating a better understanding of the interaction of wood with adhesives, and the subsequent reaction with service conditions."

With more than 20 published papers and research reports to his credit, Dr. Marra is currently involved in a half a dozen new research projects on various aspects of wood adhesion. He received his B.S. and M.S. degrees from New York State College of Forestry 1940 and 1942, respectively, and his Ph.D. from the School of Natural Resources, University of Michigan, Ann Arbor, Mich., in 1955.

Borden Financial Report

In reporting a 3.8 per cent increase in its 1959 net earnings and a 2.9 per cent increase in sales, the Borden Co., New York, N.Y., for the first time disclosed the results of its unconsolidated foreign operations. Consolidated net income in 1959 amounted to $25,548,693, equal to common share earnings of $5.21, compared with $24,612,475, or $5.06 per share for the 1958 fiscal year. The 1959 figure was a new high for the fourth consecutive year. Net sales for 1959 rose to a record level of $941,326,495, compared with the 1958 total of $915,024,172.

In its disclosure of unconsolidated foreign results, sales of such subsidiaries were $70,626,961, an increase of 19.8 per cent over 1959 when they totaled $58,923,904. Net income advanced to a record level of $4,216,356 in 1959 from $3,432,190 in 1958, a gain of 22.8 per cent. Borden's equity from these earnings was $3,775,960 in 1959, against $3,203,443 the year before. Dividends paid to the company, after income taxes, amounted to $1,445,260 in 1959, compared with $720,360 in 1958. Net assets of the unconsolidated subsidiaries, which are located in 15 countries, were $25,864,477 in 1959, against $24,053,472 a year earlier. The firm's equity in these assets rose to $23,394,571 from $21,921,058 in 1958.

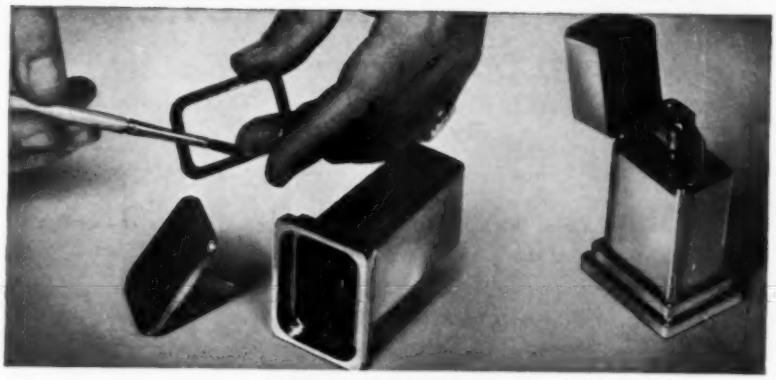
FMC Drops Division Name

The name of Westvaco has been dropped by Food Machinery & Chemical Corp., New York, N.Y., from its divisional and brand identifications. The former Westvaco Divisions are now known as the Chlor-Alkali and Mineral Products Divisions. The Chlor-Alkali Division is a producer of caustic soda, chlorina, soda ash and solvents. Mineral Products Division is a fully integrated manufacturer of phosphates, barium products and magnesias. According to FMC, these chemicals and all other products of the two divisions formerly identified with the Westvaco name now are being identified as FMC chemicals.

Morningstar Income Up

Morningstar-Paisley, Inc., New York, N.Y., reports a net income for 1959 of $663,904, equal to common share earnings of $1.33, compared with the 1958 figure of $550,524, or $1.11 per share. The firm's net sales for the 1959 fiscal year ending December 31 amounted to $25,262,997, compared with $23,136,122 the previous year.

BONDING PROBLEM?



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By MELVIN NORD

Adhesive Tape with a Gas Plated Metal Film for a Conductor

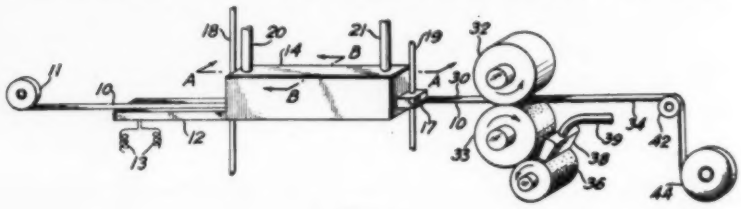

Figure 1

U. S. Patent 2,916,398, issued Dec. 8, 1959 to Philip R. Marvin and assigned to Union Carbide Corp., describes a method of preparing adhesive tapes having a conductive metallized surface deposited by gas plating. These tapes are useful in manufacturing such items as printed circuits.

As shown in Figures 1 and 2, a cellophane tape film *(10)* is unwound from a storage roll *(11)* and advanced over a heating pad *(12)* which is heated by electrical resistors. The heated tape is then passed through a gaseous plating chamber *(14)* which is filled with a heat decomposable gaseous metal compound of a metal which is to be plated onto the surface of the tape.

The chamber *(14)* is provided at opposite ends with gas locks *(16* and *17)*, inert gas such as CO_2 being introduced through the conduits *(18* and *19)* to provide a gaseous seal for the plating chamber *(14)*. The pressure of the carbon dioxide in the gas locks *(16* and *17)* is maintained sufficiently high to prevent leakage outwardly from the chamber of the gaseous metal compound. Gaseous metal compound is admitted to the chamber *(14)* through an inlet conduit *(20)* and circulated over the heated tape *(10)* and discharged through the outlet opening *(21)* at the opposite end of the chamber. Baffles *(23)* are arranged in the chamber *(14)* to deflect the gaseous metal downwardly and in contact with the moving tape. During passage of the tape through the gas plating chamber *(14)*, metal is deposited on it by decomposition of the heat decomposable gaseous metal compound, and a deposit of the metal constituent formed. The metallized sheet is drawn upwardly between the operating rolls *(32* and *33)* and coated with adhesive material *(34)* on the opposite or underside of the tape. For accomplishing this the roll *(33)* is supplied with adhesive from a spreader roll *(36)* which is arranged to receive adhesive material through the adaptor *(38)* which is connected to an adhesive storage source through a conduit *(39)*. The metallized adhesive tape is then passed over a guide roll *(42)* and is rolled up on a storage roll *(44)*.

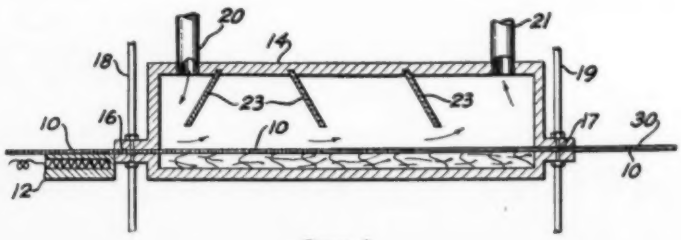

Figure 2

Cold Water Soluble Amino Alkyl Ethers of Starch

U.S. Patent 2,917,506, issued Dec. 15, 1959 to Carlyle G. Caldwell and Otto B. Wurzburg, assigned to National Starch & Chemical Corp., describes a method for producing cold water soluble amino alkyl ethers of starch. These starch derivatives are of value as wet end additives in the manufacture of paper, notably increasing the strength of the finished paper.

Starch, in the presence of at least 10 per cent water based on the weight of anhydrous starch, is treated in the presence of an alkaline medium with an etherification reagent capable of introducing a tertiary amine group. The product of this reaction is a tertiary amino alkyl ether of starch.

Non-Blocking Adhesive Sheet

U.S. Patent 2,915,413 issued Dec. 1, 1959 to Robert O. Ragan and Robert F. Trant, assigned to United Biscuit Company of America, relates to a non-blocking heat-sealable adhesive sheet.

As shown in Figure 3, the sheet consists of a thin layer *(12)* of soft aluminum foil. To one face of the foil *(12)* a sulfite paper sheet *(14)* is bonded by a resin emulsion adhesive layer *(16)*, the other face of the foil *(12)* being left exposed. The

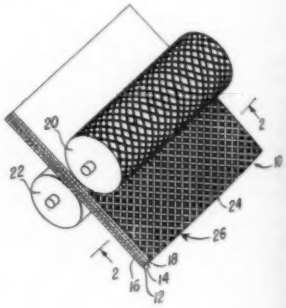

Figure 3

second face of the paper sheet *(14)* carries a uniform layer *(18)* of a heat-sealable microcrystalline wax adhesive.

Such a sheet is shown being fed between a pair of rotatable rolls *(20* and *22)* with the adhesive layer *(18)* uppermost. Roll *(20)* is a gravure printing roll prepared in the usual way from a screen, for example, an 85 line Ben Day dot screen. Roll 22 cooperates with the roll 20 to maintain the sheet *(10)* in proper contact therewith for printing. A suitable

non-blocking composition is applied to the roll 20 in the conventional way that ink is usually applied to gravure printing rolls. As the sheet *(10)* passes between rolls 20 and 22, roll 20 prints an image of the gravure screen on the surface of the adhesive *(18)* in the form of small dots *(24)* of the non-blocking composition. The non-blocking layer *(24)* is then dried to provide the finished sheet *(26)*.

Water-Resistant Adhesive

U.S. Patent 2,916,469, issued Dec. 8, 1959 to Joginder Lal and assigned to H. D. Justi & Son, Inc., describes a method of preparing an adhesive composition which is resistant to water and adheres to metal, glass, porcelain, tooth ivory, polymethyl methacrylates, and polystyrene surfaces.

It is prepared by mixing and polymerizing methyl methacrylate and a copolymer of (1) 0.1-15 per cent methacrylic acid, (2) 5-30 per cent styrene, (3) 5-40 per cent acrylonitrile, and (4) a compatibilizing methacrylate ester. The polymerizing is effected in the presence of benzoyl peroxide and N,N-dimethyl-p-toluidine.

Other Patents of Interest

Subject	Inventor or Assignee	Patent No	Date
Epoxy resin adhesives	Shell Development Co.	2,915,490	12/1/59
Apron taper	Minnesota Mining & Mfg. Co.	2,916,078	12/8/59
Portable hand tape folder	Ernest H. Schiefer	2,916,079	12/8/59
Polyurethane type bonding compositions	General Electric Co.	2,916,403	12/8/59
Carton sealing	Roy S. Sanford & Co.	2,916,860	12/15/59
Flat gummed paper	Dennison Manufacturing Co.	2,917,396	12/15/59
Textile sizing copolymer compositions	Farbenfabriken Bayer A. G.	2,917,478	12/15/59
Pre-cut self-adhesive stencil	Avery Adhesive Products, Inc.	2,917,998	12/22/59
Tape dispenser	Chart-Pak Inc.	2,918,189	12/22/59
Bonding of perhalogen polymers to metallic substrates	American Cyanamid Co.	2,918,387	12/22/59
Pigment starch paper coating	American Cyanamid Co.	2,918,438	12/22/59
High strength composition heat-resistant neoprene-phenolic adhesive cement	Minnesota Mining & Mfg. Co.	2,918,442	12/22/59
Pressure sensitive tape dispenser	International Business Machines Corp.	2,919,044	12/29/59
Apparatus for pasting starch	A. E. Staley Mfg. Co.	2,919,214	12/29/59

Copies of any patents, including those described here, are available from the Commissioner of Patents, Washington 25, D. C., for 25 cents each. Do not send stamps.

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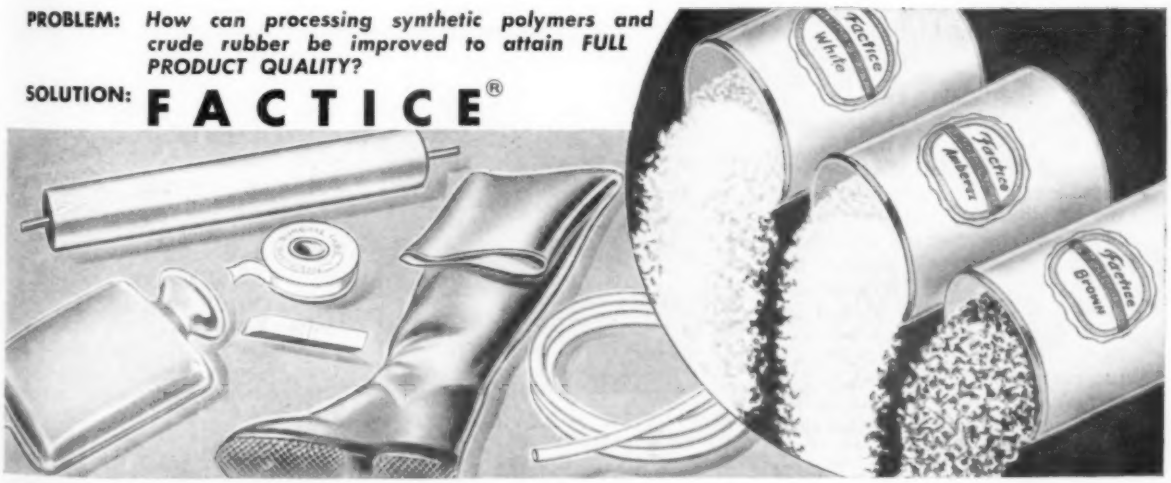

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new equipment

Conveyorized Labeler

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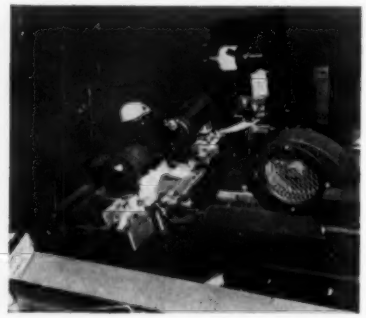


scomatic 300 Label Applicator, the machine is an auxiliary to the Amscomatic Packaging Method, a conveyorized packaging line for polyethylene packaging with fine-line tight-to-product edge seal. The labeling unit is also adaptable to any other conveyorized automatic or semi-automatic packaging line. Conveyor fed, the Amscomatic 300 accepts the package and automatically affixes a perforated edge, pressure-sensitive label. The unit uses labels that are spaced together on the backing strip rather than the more expensive type that are spaced apart, the manufacturer states. Activated by an electric eye, the attachment affixes one label to a package and can handle up to 144 packages per minute. The unit carries a label reel with power unwind that enables it to handle jumbo label reels. Labels can range in size from 15/16 to 1½ inches in height and 1 to 4 inches in width. *Amsco Packaging Machinery, Inc.*

E-184

Planetary Mixer

This heavy-duty, vertical planetary mixer is only 14 feet tall, but equipped with a 250-gallon, stainless steel mixing chamber. Specially designed paddles intermesh to perform a continuous kneading and squeezing action rather than mere stirring. One of the wedge-proof paddles is stationary, the other rotates on its own axis in a planetary orbit. The jacketed mixing chamber is raised by a separate hydraulic system to the machine head. Tight seals permit mixing under vacuum, if desired. Safety features include isolation of all bearings, gears and other moving parts from the batch. Power is supplied by a four-speed, 20-horsepower, explosion-proof motor. The unit is jacketed around its periphery to permit either cooling or heating, with a maximum internal working pressure of 50 psi. *Bramley Machinery Corp.*

E-185

Air-Operated Tape Dispensers

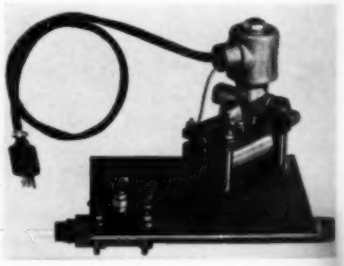
Called Scotch brand air-operated, definite-length dispensers and available in 14 different models, these portable machines automatically dispense pressure-sensitive tape to al-

most any pre-set lengths. They can be activated with a push of a valve, flick of a switch, or by simply removing a tape strip from the dispensing blades. Some machines are triggered by slight foot, finger, knee or even arm pressure, and others respond to products being conveyed on assembly lines, the manufacturer reports. The machines are designed to reduce tape waste by reducing time and effort in dispensing, and to increase efficiency by allowing more time for the taping application, the company states. The tape machines are grouped into four different series of models—802, 822, 852 and 922, and each is said to be capable of dispensing many different types of pressure-sensitive tapes. The machines, which range in weight from 22 to 74 pounds, can be equipped with four different type valves—A, AS, AT and AE. The A valve is an air valve activated by foot pressure; the AS, an air solenoid valve, is activated by foot, hand, arm, knee or conveyed product; the AT, air-operated with a time-delay switch, is activated by slight finger pressure; and the AE, an air electric valve, is activated by simply removing a strip of tape from the machine. *Minnesota Mining & Mfg. Co.*

E-186

Air-Controlled Valve

A new air operated, solenoid controlled valve has been designed for use with the Delsen Autogram automatic weighing scale. The manufacturer reports that the new valve aug-



ments the usefulness of the Autogram scale by extending its application to liquids having viscosities well over 100,000 cps. The new Series 515 valve assembly consists of a double seal ball valve, air cylinder, air manifold and a four-way solenoid valve. A wide range of body and seat materials are available for the valve itself. By proper choice of materials many difficult liquids can be handled, such as acids, bases, ketones, amines as well as liquids containing abrasive fillers, the company states. By using a small amount of air pressure, 3 to 15 psi, in the liquid reservoir, adequate flow rates are said to be obtained for the more viscous fluids. *Delsen Corp.*

E-187

Hopper Activator

Vibra Screw Hopper Activator is said to guarantee reliable flow of dry materials from any hopper or storage bin. The device features separate mechanical vibrating and pneumatic mechanisms with universal application to any size hopper or any

type of dry material. According to the manufacturer, the principle of the activator is to disturb materials by importing vibrations directly into the mass of materials rather than through the structures in which they are stored. The hopper activator consists of a vibrating shaft with attached spiders or vibrating arms, which is centered vertically from the base to the top of the hopper. The entire vibrating assembly is mounted on an air cylinder, which when activated, causes the assembly to move up and down slowly through the material. The stroke is approximately one foot according to the size of the hopper and the material it contains. *Vibra Screw Feeders, Inc.* ***E-188***

Bond Strength Tester

A portable instrument, the Dillon Dynamometer is said to be able to measure the strength of resinous materials such as asphalt, concrete, or any sheet material such as metal, wood for fiberglass, or to test the holding power of glues, mortars or even mechanical fasteners. The manufacturer states that by combining the dynamometer with a screw jack and certain materials found in any shop, a highly efficient tensile tester can be easily and inexpensively fab-

ricated. The testing assembly consists of two parts: a hook with a plug that is anchored within or on the underside of the material to be tested; and a Dillon Dynamometer integrated with a screw jack. The latter assembly is placed over the anchored hook so that the hook and the dynamometer clevis are joined. The jack is turned slowly until the material being tested gives way, and at that moment the dynamometer records the actual bond or tensile strength in pounds. The unit is available in 13 capacities, from 500 to 100,000 pounds and with either 5 or 10 inch dials. The dynamometer comes equipped with complete red maximum pointers, shackles and safety glass crystal. *W. C. Dillon & Co., Inc.* ***E-189***

Photoelectric Pickups

Reported to be miniature in size, these electronic pick-ups permit electric eye counting and controlling units to be used in processing, printing and machine controls in areas hitherto inaccessible. The over-all size of the photo unit and light unit is 1 13/16 by 1 5/16 inches and 11/16 inch in diameter. According to the manufacturer, the pickups may be used either to detect interruption of light beam by a passing box, edge of sheet, etc. The reflecting type units can be used to monitor, register, differentiate between surface quantities, or to establish motion limits of paper or plastic sag. *Photomation, Inc.* ***E-190***

FOR MORE INFORMATION on the new equipment items described here, use the Reader's Service Card in this issue.

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book reviews

Package Design Engineering. ***By Kenneth Brown. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y. 6 x 9 in. 263 pp. $8.50.***

Fundamental engineering principles in package design are explained at an elementary college text level in this book which the author originally prepared for his course at the University of California in Los Angeles. The rudiments of mechanics, statics and dynamics preface a discussion of materials handling and packaging. Four chapters are devoted to the design characteristics of the tension spring, rubber shear mount, solid cushioning and canvas strap suspension— liberally illustrating these basic systems with photographs, diagrams and charts. The three following chapters evolve a design which allows a package to have maximum protective capacity, based on the specific application and on the degree of abuse that it is expected to withstand (environment, dehumidification, pressurization, shock, corrosion and fungus attack). The concluding section investigates the peculiarities of corrugated, sheathed crate, plywood and metal shipping containers.

Although there are several references to actual packaging situations, the main emphasis is on theory and, where this becomes more advanced, as in the case of vibration analysis, only the simplified equations are given. Particular attention is paid to the requirements of military electronics equipment which demands special care in shipping and storage. Occasional mention is made of adhesion factors, mostly as they bear on the closure of fiberboard containers. This book—the second in Wiley & Sons' "Materials Handling and Packaging Series"—should prove helpful to the designer and engineer; however, its problem-solution approach recommends it particularly to the student of this subject that has grown so complex during the past ten years. Many practical design problems are worked out; others are left as exercises for the reader.

Handbook of Industrial Research Management. ***Edited by Carl Heyel. Published by Reinhold Publishing Corp., 430 Park Ave., New York 16, N.Y. 6 x 9 in. 513 pp. $12.00.***

Can research be married to management? How can research translate its findings and promises into terms understandable to the decision makers? How can the front office best communicate policy objectives and economic limitations to the laboratory?

Top management people, research directors, departmental executives and financial controllers are all vitally interested in these basic issues in order to develop the most effective industrial research programs possible. If the 33 experts in research management who contributed to this volume do not come up with ultimate answers, they do succeed in spelling out the problems and offering a host of useful practical suggestions. For example, the treasurer and the manager of the Washington office of a major research firm describe some of the major advantages and drawbacks of government contract work. The author of a book on automation outlines the uses of electronic computers in research. A professor of business administration writes on budgeting. A noted lawyer discusses patents.

Each of the 17 chapters is crammed with proven criteria for organization, evaluation and control of research. In these decades, when even the smallest companies have to develop improvements and innovations in products and techniques to compete, grow and diversify, it is comforting to find such sound professional guidance through a field nearly as nebulous as it is gigantic. The value of this treatment is enhanced by the consistently lucid presentations: beginning with fundamentals, drawing on actual business cases and indicating where more specialized material can be located. Theory must be wedded to practice in managing as well as in conducting research.

Surface Coating Resin Index. ***Published by the British Plastics Federation and the Surface Coating Synthetic Manufacturers Assn., 47-48 Piccadilly, London W.1, England. 5½ x 8¾ in. 78 pp. 5 shillings (70¢).***

The proliferation of manufacturers' catalogs in the synthetic resin field makes an occasional compendium of trade names and physical properties a helpful technical guide. A trade organization generally constitutes the ideal central and objective clearing house for such classifications. Here we have a new edition of a manual supplying basic information on British-made surface coating synthetic resins at present available to the paint, printing ink and allied trades.

Products are listed according to 15 admittedly arbitrary types which beg the question of mixed ingredients and have to allow for a rather extended "miscellaneous" category. Furthermore, the technical data provide relatively little information on application methods, main uses and such characteristics as color and shelf life. The listings are also far from all-inclusive. These are fairly minor cavils, however, when one considers the added coverage afforded by this new edition, the more than eighty basic products described, and the prospects for ever more inclusive supplements and newer versions.

Trade Literature

Scotch-Weld Structural Adhesives. A new 16-page, three color, 8½ by 11 inches, fully-illustrated, file-tabbed catalog containing complete information on Scotch-Weld Brand structural adhesives and structural adhesive design concepts, joint designs and bonding methods. The inside back cover of the catalog has an integral envelope portion for filing future Scotch-Weld adhesive data sheets. Included in the catalog is extensive technical information: tables and line drawings dealing with types and properties of Scotch-Weld film; one-part heat curing and two-part chemically curing adhesives; proper design methods for structural adhesive bonding; typical structural adhesive joint designs; and fabrication methods including surface preparations, adhesive application and bonding equipment. Case histories illustrating how Scotch-Weld adhesives are used to solve structural assembly problems are also included. *Minnesota Mining & Mfg. Co.* *L-217*

Electric Eye Application. Bulletin No. 522 describes the wide range of application for electric eyes directly to process industries. By means of problem and solution, the bulletin covers some usual and unusual installations that have been made for instant and accurate monitoring of process flow. The bulletin points up techniques used for either gasses or liquids and describes standard and special instruments. Drawings of sample tanks and look boxes are also included. *Photomation, Inc.* *L-218*

Vinyl and Styrene Resins. New physical forms of both vinyl and styrene resins is the subject of a technical release entitled, "Bakelite Brand Fibrous Resins for Specialty Paper." The release discusses the economical incorporation of these materials in paper with conventional equipment. Possible uses for the fibrous resins, such as laminating, pulp and paper molding, and bonding of asbestos and glass fiber mats, are listed in the release. *Union Carbide Plastics Co.* *L-219*

TECHNOLOGY OF ADHESIVES AT YOUR FINGERTIPS

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- **Adhesive Bonding of Metals—G. Epstein. $2.95.** Considers adhesives used with metals, indicating when an adhesive-bonded joint is advantageous; the type adhesive to use; how to use it, and how to design the joint for optimum performance. ☐

- **Adhesive Bonding of Reinforced Plastics—H. A. Perry. $8.75.** Survey of the design and assembly of structures and products, particularly glass-fiber-reinforced plastic products, by means of adhesives. Gives data on equipment and methods used to produce adhesive bonded joints. ☐

- **Adhesion and Adhesives—N. A. De Bruyne and R. Houwink. $13.50.** A collection of information on the scientific and technological aspects of adhesion. Part I deals with theory, while Part II is devoted to the technology of adhesion. ☐

- **Epoxy Resins—Their Applications and Technology—H. Lee and K. Neville. $8.00.** Guide to the field of epoxy resins, covering the chemistry of their preparation and applications, including a section on adhesives. ☐

- **Polyamide Resins—Donald E. Floyd. $4.50.** Discusses in detail various important applications of the polymers belonging to the polyamide resin family and includes a comprehensive section on adhesives. ☐

- **Principles of High Polymer Theory and Practice —A. X. Schmidt and C. A. Marlies. $13.50.** Study of the principles of high-polymer theory and practice, with a section on adhesives, their applications, and mechanisms and factors involved. ☐

- **Recent Advances in Gelatine and Glue Research —G. Stainsby (Editor). $12.00.** Study of Collagen, and its protein gelatine, comprising papers and Proceedings of an International Conference of the British Gelatine and Glue Research Association. ☐

- **Vinyl Resins—Mayo Smith. $5.75.** Surveys applications of vinyl resins with information on their types, properties, chemistry, manufacture and fabrication. Includes information on several types of adhesives in this category. ☐

- **Epoxy Resins—Irving Skeist. $5.50.** A chapter on adhesives is included in this complete study of the entire field of epoxy resins. The author gives formulations, trade names, methods of manufacture and applications. ☐

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Custom-Built Elastomers. Bulletin No. 902 is a new six-page brochure which describes capabilities in designing of custom-built elastomers. The bulletin, entitled "Achieving Better Designs with Custom-Built Elastomers," features illustrated examples and emphasizes that feasibility of a new product idea may depend on the availability of the elastomer. The bulletin presents other valuable information useful to those faced with designing new products that require specialized elastomeric properties. Another feature is a two-page chart which lists the general properties of the ten major elastomers. It describes the origin and composition of natural rubber and nine synthetic elastomers, and lists their physical and chemical properties, processing properties, and environmental resistance characteristics. *Lord Mfg. Co.* **L-220**

Economic Forecast. A 15-year forecast of United States economy is summarized in "The Years Ahead: 1960 to 1975," a 40-page, 4-color booklet. The projections of currently measurable economic trends are the results of a special one-year economic study to project our nation's economic outlook, particularly as it relates to expanding markets, research and development, and the growth opportunities ahead for industry. *American-Marietta Co.* **L-221**

Packomatic Omnimatic-Rotopress. Design specifications and application data for the Packomatic Omnimatic-Rotopress machine, which seals and discharges shipping cases of varying dimensions within a wide range of case sizes in random order—fully automatically, is described in this eight-page brochure. Complete operating details are covered both editorially and pictorially in Bulletin 100-60. A table of models, sizes, speeds and ranges of each accompanies plan and elevation drawings of the units. *J. L. Ferguson Co.* **L-222**

Lay-Flat Hand Clamps. A two-page bulletin describing the manufacturer's complete line of hand clamps designed to meet present day clamping needs. The bulletin presents data on such clamps as wood bar with fixtures, steel, light weight, heavy duty, blocking, strip gluing, extra long, and screw jack. *Nels J. Billstrom, Inc.* **L-223**

Coated Abrasives Selector Chart. This chart, designed for use in textile mills, carries recommendations for coated abrasives to be used in the card room, carpenter shop, machine shop, mill maintenance and safety, and the roller shop. The chart is 8½ inches wide and 22 inches long, and red, white and blue in color. *Carborundum Co.* **L-224**

Synthetic Resin Guide. Bulletin 121 contains selector charts for synthetic resins, foams and bonding agents used in electronic design and assembly. The charts have vari-colored columns for easy reading, and the processes contain illustrations for better understanding. The resin chart describes resins in three types—hard, semi-rigid, and flexible; foam data is covered under rigid and flexible types; and the bonding agent data appears at chart intersections which show the proper bonding agent for adhering different materials. *Plastic Associates.* **L-225**

Film Laminator. The various features of the Haas Dry Process film laminating machine are described in this catalog. The unit is designed for use on the customer's premises. The catalog answers such questions as: What is Haas lamination?; Why laminate?; What do you laminate?; and presents pertinent operating facts about the laminator. *Haas Laminator Corp.* **L-226**

Sealing Cast Stone. This four-page pamphlet deals with the use of poly sulfide sealants to seal cast stone. Procedures of application and preparation are presented in text and photographs of actual stone sealing operations. *Thiokol Chemical Corp.* **L-227**

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Here and There

What with all the ferment about more assistance for our aged citizens, the story is told about the employee who dropped this idea in the company suggestion box: "Develop a program whereby we young workers can retire now and start working when we're 65" . . . Going swimming this summer? An aerosol shark repellent is being marketed by Par Industries of Los Angeles . . . Heard this explanation of what it is that statisticians do? It goes like this: One hundred men went into the woods to cut logs. They took along two women to cook for them. Before the winter ended, two of the men married the women. Along came the company statistician and figured out that 2 per cent of the men had married 100 per cent of the women . . . Red Face Department—Firemen in Marine, Ill., proudly entered a float in some local festivity but failed to win a prize because the float caught fire . . . Motorists of Amherst, Mass., were rewarded recently for going through 1959 without a traffic fatality. The city fathers gave all motorists a full day of free parking at all parking meters in the city . . . And as a follow-up to the car which featured a bed, a manufacturer is said to be considering a bed that converts into a car.

Here We Go Again

What is going on in May? Well, during the month we will be observing—Be Kind to Animals Week—Goodwill Week—Mental Health Week—National Correct Posture Week—National Home Demonstration Week—National Camp Week—National Family Week—American Bicycle Month—National Association for the Advancement of Ornamental Iron Month—National Foot Health Month—National Home Improvement Month—National Tavern Month (this one *we* like)—National Frozen Food Week—National Girls' Club Week—National Hospital Week—Let's Go Fishing Week—National Domestic Rabbit Week—Mute Your Muffler Month—National Cotton Week—National Pickle Week—Annual Foot Health Week—Armed Forces Day—National Maritime Day—American Merchant Marine Book Week—Memorial Day—and, of course, Mother's Day. Who will join the movement for a "Leave Us Be" Month?

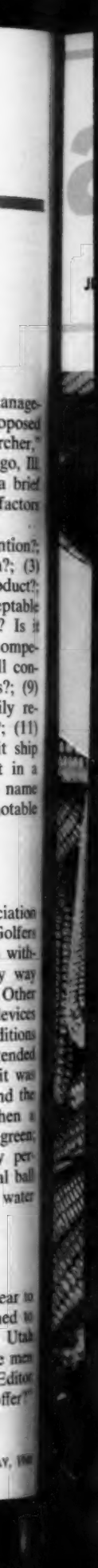
Packaging Questions

The following list of questions which management might ask about its current or proposed packages is taken from "The Nielsen Researcher," published by the A. C. Nielsen Co., Chicago, Ill. While it is not exhaustive, it manages, in a brief series of queries, to touch upon the key factors governing the effectiveness of packaging.

(1) Does the new package attract attention?; (2) Is it adaptable to existing production?; (3) Does the style suit the nature and use of product?; (4) Does it reflect quality?; (5) Is it acceptable to trade? Will it stack?; (6) Will it last? Is it tamper-proof?; (7) Does it look well in competition with other packages?; (8) Does it tell consumer how to use it, or suggest new ways?; (9) Does it whet the appetite? (not necessarily restricted to food); (10) Is it easy to open?; (11) Does it protect the product?; (12) Does it ship easily, safely?; (13) Is there a price spot in a prominent place?; (14) Are brand and name easily identified?; (15) Does it have promotable features?

Golfers: Attention!

Two major changes in U.S. Golf Association rules went into effect on January 1, 1960. Golfers can now clean the ball on the putting green without penalty and repair ball marks in any way except by stepping on the damaged area. Other new angles to the old rules: Artificial devices can't be used for gauging distance or conditions that might affect play; flagstick can't be attended or removed while the ball is in motion if it was not attended before the play; no penalty and the ball must be replaced if it is moved when a player moves a loose impediment on the green; practice on course on day of match play permitted unless committee says no; provisional ball not permitted for ball unplayable or in water hazard.

See What We Mean?

"It seems to me that every issue you appear to mention the same men," a reader complained to the *Pointer News*, inmate publication of Utah State Prison. "Are you one of those horrible men that accept payola?" the letter asked. Editor Quay Kilburn's reply: "What is your best offer?"